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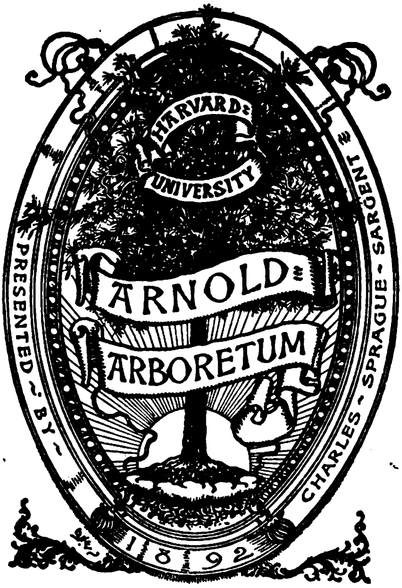
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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 51.
B. T. GALLOWAY, *Chief of Bureau.*

MISCELLANEOUS PAPERS.

I. THE WILT DISEASE OF TOBACCO AND ITS CONTROL.

By R. E. B. McKENNEY, *Physiologist.*

II. THE WORK OF THE COMMUNITY DEMONSTRATION FARM AT TERRELL, TEX.

By SEAMAN A. KNAPP, *Special Agent.*

III. FRUIT TREES FROZEN IN 1904.

By M. B. WAITE, *Pathologist.*

IV. THE CULTIVATION OF THE AUSTRALIAN WATTLE.

By DAVID G. FAIRCHILD, *Agricultural Explorer.*

V. LEGAL AND CUSTOMARY WEIGHTS PER BUSHEL OF SEEDS.

By EDGAR BROWN, *Botanist in Charge of Seed Laboratory.*

VI. GOLDEN SEAL.

By ALICE HENKEL, *Assistant,* and
G. FRED KLUGH, *Scientific Assistant.*

Issued February 7, 1905.

WASHINGTON:
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1905.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

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[Continued on page 3 of cover.]

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WASHINGTON:
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1905.

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BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY,
Pathologist and Physiologist, and Chief of Bureau.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.
ALBERT F. WOODS, *Pathologist and Physiologist in Charge,*
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MISCELLANEOUS PAPERS.

B. P. I.—69. V. P. P. I.—104.

I.—THE WILT DISEASE OF TOBACCO AND ITS CONTROL.[a]

By R. E. B. McKenney, *Physiologist, Vegetable Pathological and Physiological Investigations.*

THE DISEASE.

The wilt type of disease is a well-known one, affecting cotton, watermelon, cowpea, tomato, and other crops. Until the present there has been no publication bearing on tobacco wilt, although the writer has been acquainted with the disease for a number of years and some of the North Carolina growers have been troubled by it for at least ten years. Accordingly, before considering the control of the wilt it will be necessary to give a brief description of the disease and its cause.

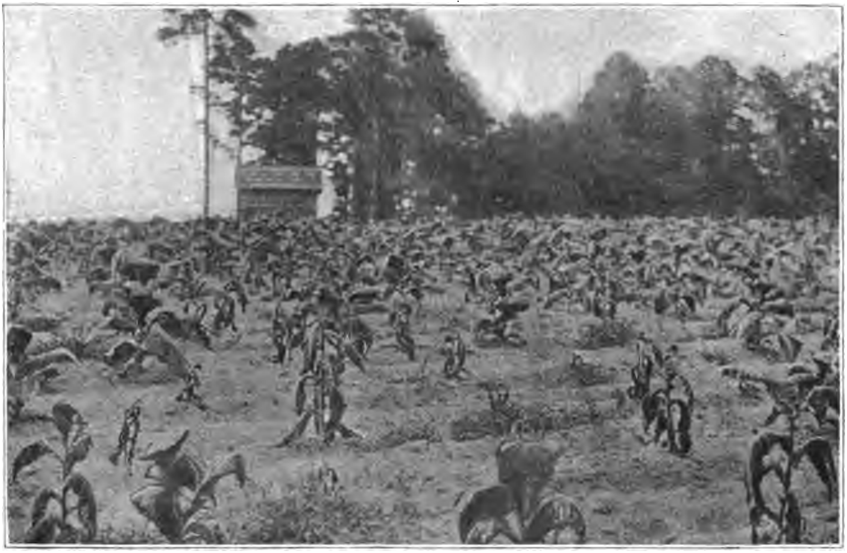

FIG. 1.—Field of bright tobacco in Granville County, N. C., affected with wilt disease.

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[a] During the past few years specimens of tobacco suffering from what appeared to be a true wilt disease have been received by the Department from a number of tobacco districts. During the past summer, however, in a certain section of North Carolina the disease was found so destructive that it is deemed necessary to make this *preliminary* statement concerning the disease and its control.

A. F. Woods, *Pathologist and Physiologist.*

Office of Vegetable Pathological and Physiological Investigations,
Washington, D. C., September 12, 1903.

So far as known the wilt disease does not make its appearance until the tobacco has attained about a third of its growth. The first evidence the grower has of the disease is the sudden wilting, or drooping, of one or more of the leaves. This wilting is not a temporary one caused by intense sunlight and excessive heat, but a permanent one, followed by withering of the wilted leaves. In some cases only a few of the leaves are killed. As a rule, though, the wilting of a few leaves is followed by wilting and the subsequent withering of all the leaves of the plant. (Fig. 1.) Later the base of the stem blackens and rots. An examination of the roots at this stage of the disease shows them likewise to be blackened, and usually soft and mushy. As a rule, the first diseased plants are found in the washes and lower parts of the field. In the sections where it is just making its appearance the disease may be confined to a few plants in the field. At times nearly the entire field will go down with the disease during the first year. In almost all cases the second crop planted on such infected fields is sure to be practically a complete loss.

CAUSE OF THE DISEASE.

Although the disease has not been studied to the same extent as the wilts of cotton, watermelon, and cowpea, still the history of the wilt in the field and the microscopic examination of diseased plants show this disease to be of the same type as the wilts of cotton, watermelon, and cowpea already worked out by Dr. E. F. Smith and Mr. W. A. Orton, of the Department of Agriculture. Microscopic examination of wilted tobacco always reveals the presence of a fungus belonging to the genus *Fusarium* (*Neocosmospora*). This is found in the woody parts of roots and stem. The black lines running up through the wood of the stem readily reveal to the naked eye when cut or broken across the passage of the fungus up the stem.

As shown by the work on other wilt diseases, the *Fusarium* is a soil fungus, and gains entrance to the plants through the *fine roots*. It rapidly spreads into the larger roots and up into the stem. The path of the fungus is through the woody vessels which conduct the sap upward. In many cases the growth of the fungus is so great that the woody vessels are almost, if not completely, plugged up. The flow of crude sap up to the leaves is either very much decreased or entirely stopped. Since there is no supply of water from the roots to replace that evaporated from the surface of the leaf, the leaf wilts and dies.

CONTROL OF THE DISEASE.

Once a plant becomes affected by the disease there is no hope of its recovery, and when the larger part of the field is affected the crop is a total loss to the grower. Sudden droughts have been said to arrest the progress of the disease, but they do not save the crop. The treatment of the wilt must be one of prevention—that is, the spreading of the disease must be prevented, and an effort made to rid the infected fields of it. In treatment of the disease, it is of the greatest importance that the long-lived character of the moldlike threads of the fungus in the soil and its manner of reproduction, or, more popularly speaking, of seeding itself, be borne in mind.

The Fusarium has been known to live in the soil for a number of years and still be able to produce the disease. This is particularly true in districts with mild winters. It is therefore useless to plant tobacco on infected fields until they have been rested for a period of from five to eight years, depending upon the amount of disease present. During this resting period sorghum, corn, wheat, oats, or any other crop of the grass family may be planted with safety, since these are not subject to this disease. Sorghum and corn are particularly recommended. Tomato and eggplant also suffer from a wilt disease. That the tobacco wilt is the same as that affecting these plants has not yet been proved, but the relations of the tomato and eggplant to tobacco make it not improbable that all three may suffer from the same disease.

In order to eradicate the disease, it is necessary that all source of infection of new fields be destroyed. All diseased plants should therefore be *burned on the field where they were grown.* The burning of the plants does not mean any loss to the grower, because the chief fertilizing value of the tobacco stems lies in the amount of potash which they contain. In the burning the potash is not lost, but is retained in the ash, and has fully as much value as before burning. If the diseased plants are not burned, they are scattered about and serve to inoculate new fields. Plows and other tools used on the infected lands should be cleaned where used. Since the growth is favored by acid substances and hindered by alkaline substances, washing the tools with soap and water is advised, since the slight alkalinity of the soap acts injuriously on the fungus. None of the diseased tobacco should be mixed with manure or compost heaps, since the fungus spreads rapidly through the manure, and when that is placed on the land, of course the land becomes infected with the disease. Manure barns in which diseased tobacco has been placed should be burned and barns erected on new land. A number of cases are known where the disease has lived in the manure sheds for years.

As an additional means of getting rid of the fungus it is advised that the tobacco stubble be plowed up in the *autumn* and burned on the field. The reason for this is twofold. In the first place, this stubble is a good breeding place for the fungus during the winter; secondly, of the three kinds of fruiting or seedlike bodies formed by the Fusarium the one most difficult of destruction is produced on the roots during the autumn and winter. By turning up the stubble in *autumn* and burning it these seedlike bodies are either prevented from forming or are largely destroyed, if already formed. Tobacco suffering from wilt will rarely set seed, but should such happen the seed should not be used, because it would be poorly formed and yield only weak seedlings.

The most successful method of combating wilt diseases has been found to be the selection and breeding of resistant varieties. For the cowpea and cotton this has been accomplished by Mr. W. A. Orton of this Department. The writer has selection experiments under way which may yield a váriety of tobacco resistant to the disease. Until such a resistant variety is obtained, however, it is essential that the precautions just advised be taken. If they are not taken the ravages of the disease will become greater, whereas if they are followed the disease may be prevented from spreading to new fields and probably to a large measure may be eradicated from old fields.

As an additional precaution it is recommended that no fertilizers containing kainit or muriate of potash be used. These are not only believed to make conditions favorable for the continuance of the disease, but they also give the leaf poor texture and bad burning quality. In soils deficient in lime an application of 50 bushels to the acre may prove advantageous. Care must be taken, however, not to use too much lime, since that also causes the leaf to burn poorly.

Observations and experiments on this disease will be continued, and it is hoped that a surer method of control may be obtained in the near future.

B. P. I.—93.

II.—THE WORK OF THE COMMUNITY DEMONSTRATION FARM AT TERRELL, TEXAS.[a]

By Seaman A. Knapp, *Special Agent in Charge of Farmers' Cooperative Cotton Demonstration Work.*

INTRODUCTION.

The work of the Porter Demonstration Farm at Terrell, Tex., for 1903 having been completed, I take pleasure in submitting a detailed report of its operations and results.

Acting upon instructions, I visited Terrell and organized the farm upon a practical basis.

A committee of business men and farmers was appointed to carry out the plans agreed upon. This committee was composed of W. E. Flower (president), B. T. Childress, J. B. Porter, Walter C. Porter, J. N. Stallings, F. B. McKay (secretary), W. E. Henderson, and C. T. McGinnis. Great credit is due these gentlemen for their judicious management and intelligent services.

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[a] In connection with the work of the United States Department of Agriculture in Texas and Louisiana in demonstrating the possibility of growing diversified crops with greater profit than results from confining attention to a single farm product, and also in showing the value of better cultural methods, it seemed desirable to make special demonstrations in certain communities of the benefits which would be derived from the rotation of crops, thorough cultivation, the intelligent use of fertilizers, etc.

The citizens of Terrell, Tex., offering to pay the expenses of such a demonstration, Dr. Seaman A. Knapp, Special Agent in Charge of Farmers' Cooperative Cotton Demonstration Work, was sent to that city and organized a farm on the general basis outlined in this report.

It is believed that, though only simple tests were made, results of sufficient value to justify calling special attention to them have been obtained. The statement of the season's work is not presented as a contribution to the science of agriculture, but merely as a record of what was done by one farmer acting under the directions of a representative of the United States Department of Agriculture, together with that farmer's testimony that he found decided financial benefit resulting from following those directions.

Every good farmer can do work of this sort, and every wide-awake community can organize a demonstration farm to show the people in its section that marked financial advantages will accrue if better methods of soil culture, etc., are followed.

B. T. Galloway, *Chief of Bureau.*

United States Department of Agriculture,
Bureau of Plant Industry,
Washington, D. C., January 29, 1904.

The demonstrations were under the immediate management of Mr. Walter C. Porter, one of the most capable farmers in north Texas, while the general control of the experiments was placed in my hands.

The object of all such demonstrations is to test or prove some important fact bearing upon agricultural conditions. If these demonstrations are conducted in such a way that few persons see the result or learn about it, little is accomplished. The plan adopted by the committee at Terrell involved keeping in touch with the work on the part of the large number of business men and farmers who had subscribed to the guarantee fund, and who accordingly made frequent inspections of the farm in order to see how the work was progressing, a personal interest being taken in learning for themselves that the methods followed were in accordance with the best agricultural practices.

RESULTS ACCOMPLISHED.

Upon the final settlement for the operations of the Demonstration Farm for the season, Walter C. Porter, the farm manager, announced that he had cleared $700 more than would have been made under the ordinary methods of farming employed in that section, and he stated that in 1904 he should work his entire farm, about 800 acres, upon the basis of the same cultural methods which had been followed on the experimental plats. Many of the owners of large farms in that section of the State made similar announcements.

Hon. E. H. R. Green, of Terrell, Tex., became greatly interested in observing the results accomplished on this Demonstration Farm, and his interest took a practical direction when, in November, 1903, he purchased 410 acres of land lying adjacent to the city of Terrell and at once invested a large amount of money in improvements, with the intention of establishing one of the most complete demonstration farms in the United States.

METHODS EMPLOYED.

The methods employed by the citizens of Terrell in establishing this Demonstration Farm may be summarized as follows:

(1) Eight practical men were selected to act as an executive and advisory committee, with full authority.

(2) The citizens subscribed a sum of money sufficient to guarantee that any contract made by the committee would be carried out.

(3) One of the best farmers in the section was chosen to conduct the demonstrations upon his own farm. He was to follow strictly all instructions given by the representative of the Department of Agriculture, and if the result showed financial losses owing to changes from the methods formerly employed he was to be fully reimbursed out of the fund subscribed by the citizens.

It was the intention the first season merely to test varieties and to investigate the effect of fertilizers, methods of cultivation and planting, etc., leaving any special effort to produce large crops for subsequent years after the soil conditions had been accurately determined. It was considered wise to restrict the tests to the ordinary farm crops of the section.

DESCRIPTION OF THE FARM.

The demonstrations were made on a tract of about 70 acres of moderately rolling, light, sandy loam upland, underlaid with clay at a depth of about 2½ feet.

This land had been planted to cotton or corn every season for twenty-eight years without the use of a commercial fertilizer and without employing any renovating crops, except upon Plat No. 2, which was planted in corn and cowpeas the preceding year. Nearly all the humus had been removed from the soil of this farm by successive cropping until both the corn and cotton grown upon it indicated an impoverished condition of the soil.

The entire tract had been plowed in January about 4½ inches deep with an ordinary turning plow. This was prior to the establishment of the Demonstration Farm.

FERTILIZERS USED.

The basis of all fertilizers used was the following compound:

Available phosphoric acid, 10 to 12.
Total phosphoric acid, 12 to 15.
Bone phosphate of lime, 26 to 32.
Potash sulphate, 8 to 12.
Potash KO_2, 4 to 6.

To this compound was added one-third of its weight of cotton-seed meal, the resulting fertilizer being known as mixture No. 2. On Plats 1, 4, 6, and 8, 200 pounds of this mixture were sown broadcast upon the land after planting. On Plats 3, 5, 7, and 9, no fertilizer was used. On Plat 2, 200 pounds of mixture No. 2 were used per acre, dropping it equally on each side of the rows of cotton at the time of the first plowing. Plat 2, as stated, had been planted in corn and cowpeas the preceding year. The method of applying the fertilizer to this field was precisely like the others.

The following table shows the yield of cotton per acre on the fertilized and unfertilized plats:

No.	Acres.	Variety of cotton planted.	Fertilized or not.	Planted.	Yield in pounds of seed cotton per acre.	Yield in pounds of lint cotton per acre.	Pounds of lint cotton to 100 pounds of seed.
1	4	Rowden	Fertilized	Apr. 18 to 21	920	326.6	35½
2	15	do	do	do	1,167.32	414.4	35½
3	4	do	Not fertilized	do	730	259.15	35½
4	3	Gibson	Fertilized	do	826	279.84	34
5	3	do	Not fertilized	do	634	215.56	34
6	2	Russell Big-Boll	Fertilized	do	790	221.2	28
7	2	do	Not fertilized	do	711	199	28
8	3	Stormproof	Fertilized	do	718	226.15	31½
9	3	do	Not fertilized	do	670	211	31½

Two hundred pounds of this fertilizer—the amount used per acre—cost $1.54. With cotton at 12 cents per pound, the result of using the fertilizer is shown below. The first column of figures shows the gain in pounds of seed cotton by the use of fertilizers; the second column shows the value of this increased product; the third column, the cost of the fertilizer per acre, while the fourth column shows the net profit per acre.

Variety of cotton planted.	Gain in pounds of seed cotton per acre.	Gain in value per acre.	Cost of fertilizer per acre.	Net gain per acre.
Rowden, Plat 1	190	$8.11	$1.54	$6.57
Rowden, Plat 2	729.16	31.05	1.54	29.51
Gibson	192	7.71	1.54	6.17
Russell Big-Boll	79	2.66	1.54	1.12
Stormproof	48	1.81	1.54	.27

If all the gain in Plat 2, 729.16 pounds of seed cotton, was credited to the fertilizer, this would show a value of $31.05 per acre, at a cost of $1.54. It is evident, however, that some allowance must be made in this case for the crop of cowpeas grown during the previous year and for the consequent better cultural condition of the plat on which this cotton was produced.

COTTON.

Some 37 acres in all were planted in cotton, divided into nine plats or fields.

Just before planting, the land was disked, cross-disked, and harrowed. The cotton seed was planted 1 inch deep in rows 3½ feet apart, the planting drill being followed by a roller which pressed the soil after the seed was covered. The cotton came up in five or six days after planting. From May 1 to May 3 the fields were harrowed, and in about twelve days they were side harrowed and cultivated. From May 15 to May 18 the soil was chopped to 18 inches and then plowed, it being plowed thereafter once every twelve days until August 1. All plats received the same cultivation.

The bollworm in great numbers attacked the entire crop of cotton and reduced the yield at least one-half.

On the east of the Porter farm is an adjoining field of precisely similar soil and drainage, except that it had produced but three crops from a virgin state. This tract has been designated as Field A. It was in excellent condition, and was planted to Rowden cotton and well cultivated in the ordinary way without the use of fertilizers. The yield on this 30-acre tract was 10 bales of 500 pounds each, or 166⅔ pounds of lint cotton per acre, as against 326.6 pounds per acre on Plat 1 and 414.4 pounds on Plat 2 of the Demonstration Farm, showing a gain of 160 pounds per acre, worth $19.20, on Plat 1, and of 249.74 pounds, worth $29.86, on Plat 2, due to better cultivation and the moderate use of fertilizers. These amounts per acre would stand to the credit of the demonstration fields without modification, provided the soils were of equal fertility; but, as stated, the adjacent field was comparatively new and rich in humus and far better than either Plat 1 or Plat 2.

On the northwest of the Demonstration Farm is another tract of land, a rich sandy loam, which had been in cultivation only about four years, designated in the following table as Field B. It was planted to Rowden cotton and given good common cultivation, but no fertilizers were used. The product was 21 bales from 65 acres, or 161.54 pounds of lint cotton per acre, showing a gain in favor of Plat 1 of 165.12 pounds per acre, worth $19.81, and in favor of Plat 2 of 252.81 pounds, worth $30.34, due to intense cultivation and the use of some fertilizer.

A comparison of the results obtained on the Demonstration Plats and on Fields A and B further shows the proportion of this gain due to cultural methods and to fertilizers. The total gain in Plat 1 over Field A was $19.20 and over Field B $19.81 per acre. It has been shown that the amount to be credited to fertilizer on Plat 1 is $8.11 per acre. Deducting this, it leaves $11.09 credited to Plat 1 as compared with Field A, and $11.71 credited to Plat 1 as compared with Field B on account of better tillage. The culture values as compared with Plat 2 can not be made, because the effects of culture and fertilizer on Plat 2 were not separately tested.

The results for the Rowden cotton may be tabulated as follows:

Plat or field.	Character of culture.	Fertilized or not.	Total pounds of lint cotton per acre.	Pounds of gain per acre over Field A.	Gain in value over Field A.	Pounds of gain per acre over Field B.	Gain in value over Field B.	Increase in value due to fertilizer.	Increase in value due to culture over Field A.	Increase in value due to culture over Field B.
1	Improved	Fertilized	326.66	160	$19.20	165.12	$19.81	$8.11	$11.09	$11.71
2	do	do	414.4	242.74	29.86	252.86	30.34			
3	do	Not fertilized.	259.15	92.49	11.09	77.61	11.71			
A	Common	do	166.65							
B	do	do	161.54							

It is noticeable that the fertilizer and cultural methods employed had a much greater effect upon some kinds of cotton than upon others, the Rowden and the Gibson varieties proving much more satisfactory in this respect than the Russell Big-Boll and the Stormproof. Fertilizing hastened maturity about ten days.

CORN.

The land planted to corn received precisely the same preparatory treatment as that given to the cotton fields. On March 28 it was disked, cross-disked, and harrowed, and from April 4 to April 8 it was planted in corn, 2 inches deep, with rows 5 feet apart.

The following varieties were used: Native Texas corn, White Wonder, Reed's Yellow Dent, and White Pearl.

The corn came up on April 12. On this date there was a heavy hailstorm, which damaged it badly. Cultivation commenced on May 1. The corn was thinned to a stand of 18 inches in the row, and cultivation was repeated once every ten days till June 15. At this date the stalks averaged 4½ feet high, when a severe wind blew fully 50 per cent of them flat across the rows, preventing all further cultivation. Most of the stalks blown down did not recover and were a total loss, besides preventing any further test of cultural methods.

Three hundred pounds of fertilizer per acre were applied to a portion of the farm. This fertilizer was composed of equal parts of cotton-seed meal and of the compound before mentioned. It was applied at three different periods—100 pounds at the time of planting (drilled in with the seed); 100 pounds at the time of the first cultivation (on the sides of the rows); and 100 pounds about June 1 (in the middle of the rows).

The results in the case of corn are not considered of great value because of the heavy loss entailed by the June windstorm and the impossibility of continuing cultivation after that time. Further, the instructions to plant cowpeas between the rows could not be carried out except to a limited extent, on account of the prostrate corn.

A summary of the principal results obtained in the experiments with corn will be found in the following table:

Variety of corn.	When planted.	When up.	Date of first cultivation.	Date of roasting ears.	Date of maturity.	Yield per acre.		Fertilized or not.
						Bush.	*lbs.*	
1. Native Texas..	Apr. 4 to 8	Apr. 12	May 1	Aug. 1	Aug. 15	41	9	Fertilized.
2. Native Texas..	.....do.....	....do...	....do...	Aug. 10	Aug. 25	30	18	Not fertilized.
3. White Wonder.	.....do.....	....do...	....do...	July 12	July 27	32	0	Fertilized.
4. White Wonder.	.....do.....	....do...	....do...	July 22	Aug. 7	23	15	Not fertilized.
5. Reed's Yellow Dent.	.....do.....	....do...	....do...	Aug. 1	Aug. 15	22	18	Fertilized.
6. Reed's Yellow Dent.	.....do.....	....do...	....do...	Aug. 10	Aug. 25	18	0	Not fertilized.
7. White Pearl ...	.....do.....	....do...	....do...	....	....	23	10	Fertilized.
8. White Pearl ...	.....do.....	....do...	....do...	....	....	19	16	Not fertilized.

The fertilized corn was of considerably better quality than that grown without fertilizer. The results obtained by fertilizing would, of course, have been much greater had it not been for the storm referred to. All the corn in the field was gathered from October 1 to October 10.

It should be noted that the White Wonder corn was earlier than the other varieties tested. An acre of White Wonder corn was planted in rows 3½ feet apart and thinned to 28 inches in the row. The product under the same cultural treatment was 3½ bushels per acre less than where the rows were 5 feet apart.

III.—FRUIT TREES FROZEN IN 1904.[a]

By M. B. WAITE, *Pathologist in Charge of Investigations of Diseases of Orchard Fruits, Vegetable Pathological and Physiological Investigations.*

INTRODUCTION.

The severe cold weather of the past winter, especially the intense cold of January 4 and 5, resulted in very serious damage by freezing to orchards in New York and New England, especially in the Hudson and Connecticut valleys. The damage was found to be mainly to peach, Japanese plum, and pear trees, and the most serious harm was largely confined to the lower levels and pockets. The writer recently visited the orchards around Marlboro and Milton on the Hudson River, and also those located at South Glastonbury, Conn. In conversation with the growers, it was found that, as a rule, they overestimated the damage. In several cases orchards were already cut down which would probably have recovered if given proper treatment.

DAMAGE TO BEARING PEACH ORCHARDS.

In the bearing peach orchards the trees most injured by freezing show the bark entirely blackened and dead, more or less separated from the trunk, and the wood turned a very dark brown color. The injury extends far up onto the limbs, although the bark usually has not separated on the branches. Such trees are dead beyond all question and should be treated accordingly. Scarcely 10 per cent of the orchards visited were found to be in this completely frozen condition. Even on these, the bark on the branches and small limbs still retained its vitality. Such trees were largely confined to cold, low, flat places, or to pockets at very moderate elevations. Sometimes a rise of 10 or 15 feet resulted in the trees being less seriously injured.

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[a] In the hope of being of some service to the fruit growers of New York and New England whose orchards have been severely damaged by the extreme cold of the past winter, it has been thought desirable to publish from the Department a brief explanation of the damage done, with advice as to how to treat the injured orchards.

A. F. WOODS, *Pathologist and Physiologist.*

OFFICE OF VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS,
Washington, D. C., March 28, 1904.

With many peach trees, however, the bark is lightly separated from the wood, which is of a dark walnut color next the cambium and brown throughout. Though still alive, the bark is somewhat browned and discolored, the youngest or outer layer of wood has been frozen until it is now of a dark walnut color, and the wood of the trunk is blackened throughout. Many of these trees are of questionable vitality, and will probably succumb. Others have enough vitality to enable them to pull through. Where the bark is adhering or only partially separated from the trunk, the chances for recovery are good. The tops of such trees are usually found in fair condition, the wood brownish, but the white cambium layer uninjured, though lying immediately in contact with the brown, dead wood. The twigs, especially the one-year wood, sometimes have been frozen so badly that they will not be able to push the leaf buds. In severe cases the leaf buds themselves are killed, but, as a rule, they are still alive. Of course on all such trees the fruit buds are killed. The most injured part is the trunk just above the snow line. About one-half of the orchards examined were in this condition.

A third class, which may be described as the moderately frozen trees, in which the wood above the snow line is blackened but the bark not separated from the wood and with the cambium still apparently alive, although water-soaked and injured, frequently has minute brown streaks in the bark immediately in contact with the cambium. Such trees will almost invariably recover. Where orchards are in this condition, only the trees in the low situations, where there was an excess of moisture and drainage nitrogen and which also afforded basins in which the cold air was caught, may be expected to die. All such moderately frozen trees, even though the wood is blackened throughout, may be expected to yield abundant crops for several years in the future.

Nearly every tree in the entire Michigan fruit belt was frozen in February, 1899, so that the wood was blackened and dead clear to the bark. A new layer of live, white wood formed inward from the live bark, the trees made a fairly good growth, having no fruit crop to carry, and bore the year following a record fruit crop. Moderate pruning back, say from one-third to not over one-half the tops, gave the best results on trees of this character. No pruning at all gave much better results than too severe cutting back. Many trees were cut back to the large branches, or "dehorned," and failed to push out. Similar trees moderately pruned pulled through and made a fine growth.

On the higher levels aud ridges in both the Connecticut Valley and the Hudson Valley there are orchards in which some of the fruit buds have survived and in which the trees were only moderately frozen. The fruit buds apparently are more hardy than the youngest, tender sapwood. In fact, the most hardy portions of the tree are the cambium layer—an extremely thin film of very vital tissue between the bark and the wood—and the leaf buds. That portion of the tree having the most life or protoplasm in it, fortunately, is the most resistant. Young trees in orchards from one to three years old were injured less than older bearing trees. Nursery trees, on the contrary, were frozen dead to the snow line. These are entirely one-year wood, of course, and are of a rather forced, tender, sappy nature.

HOW TO TREAT THE PEACH ORCHARDS.

The orchardist should be cautious about pulling out damaged trees. Unless for some other reason than the present injury from frost he is willing to dispense with the orchard, he should give the trees an opportunity to show what they will do before condemning them. Almost all the trees in which the bark is stuck tight at the critical point—about two feet from the ground—may be expected to pull through, and many which have the bark partially loosened may recover. Moderate pruning back, followed by good cultivation and, unless the land is in very good condition, with a moderate amount of fertilizing, will be the best course to pursue. If the buds can push out in the tops, growth will extend downward, resulting in many cases in a complete covering of new, sound, white wood, even over the most injured part on the trunk. The frozen dead wood can conduct the crude sap as long as it remains moist. If the bark remains alive it will carry the elaborated sap downward from the leaves. This shell of new wood will be sufficient to maintain the tree in profitable bearing and will, of course, be added to annually. Nearly all the peach trees in Michigan, notwithstanding the fact that they have a dead, black heart, as well as many of those similarly affected in Missouri, Maryland, and Georgia, have been bearing good crops of fruit.

The aim should be, with good cultivation and fertilization, to grow the tree out of the injury. Stable manure will probably answer the requirement in some cases. Nitrate of soda at the rate of 200 pounds per acre may be preferable in other cases. The choice of the writer would be a complete fertilizer, consisting of nitrate of soda, acid phosphate or bone meal, and muriate of potash. Such a fertilizer applied just at the time growth is starting would result in the best possible benefit from the nitrate.

INJURY TO PLUM TREES.

The Japanese plums have behaved essentially the same as the peach trees. The young wood is discolored in the same manner, while the bark remains alive on very many of the badly injured trees. Their treatment should be essentially the same as that of the peaches. The Domestica plums are very little hurt, being almost as hardy, in fact, as the apples. Some injury was noted on the grapes. Two-year vines which reached above the snow line were apparently killed in some cases, but no special study was made of the injury to the grapevines.

INJURY TO NURSERY TREES.

In the nurseries, peach trees were frozen down to the snow line so as to make that portion above the line without value. However, they are entirely unharmed below the snow line and should be treated as though they had been cut off at that point. Those who prefer a high head may object to planting such trees. The choice of the writer, however, is in favor of a low headed tree, and such trees will give excellent results even though they may not have more than six or eight inches of sound wood above the bud. The writer would not hesitate to plant them. Where the trees have less than six inches of wood, probably as good a way as any would be to allow only one sprout to grow and to train up a new tree from this sprout after planting in the orchard. Where the nursery trees are not dug and sold, they may be cut off an inch or so above the bud and a single sprout trained into a tree according to the usual methods of nurserymen. It will, of course, be desirable to withhold part of the cultivation on such trees to avoid their growing too large.

The Japanese plum, as stated, has behaved essentially like the peach tree and should be treated in the same way. The apple is hardier than either of these fruits, and of the apple trees examined in the nursery only a few varieties seemed to be hurt sufficiently to cause their rejection. These frozen trees might be treated in the same way as the frozen peach trees—by cutting them off and allowing a new tree to grow from a bud.

DAMAGE TO PEAR TREES.

In the Hudson Valley the pear trees are very severely damaged. In many cases the pear orchards were placed, as is customary, on the lower, richer ground, which is naturally from its location more subject to intense cold. As far as a hasty examination went, the pear orchards seemed to be more severely hurt than the peach trees. At any rate, they were injured to about the same extent, and they have not by any means the same ability as the peach trees to outgrow the injury.

Another factor which has entered into the problem in the case of pears is a severe attack of *Psylla*. A very unusual attack of this pest last season had greatly weakened the vitality of the trees. Most of the pear orchards examined were still crusted with the black fungus which grows on the honeydew secreted by the *Psylla*. These *Psylla*-infested and weakened pear trees were in poor condition to resist the severe freeze.

Many handsome specimens 25 to 30 years old of Bartlett, Seckel, and other choice varieties were frozen outright. Several fine orchards of 8 or 10 acres in extent which the writer examined were completely killed or practically so. Here again, as with the peaches, the difference of a few feet in elevation frequently made the difference of life or death to the trees. The young pear trees are rather less hurt than the older trees, as in the case of the peach, but it should be noted in this connection that young pear trees having the wood blackened, although they will push out their leaves and make a start, are very apt to decline or else maintain their life in a very feeble manner as a result of the dead wood at the heart. They have not the ability to recover by depositing a thrifty layer of sapwood. Pear trees under 3 or 4 years of age which are badly frozen and which show blackened or discolored wood, even though the bark may look normal from the outside and may appear to be alive and quite fresh when cut into, should be cut off below the snow line and allowed to sprout. All the sprouts that start may be permitted to grow the first year, and, if a tall head is preferred, they may be pinched back, except the one which is to form the new stem, when they have grown a foot or so. The foliage from these pinched shoots will help contribute to the life and vigor of the tree. In case of badly frozen bearing trees, where the tree is dead and the bark is discolored, of course they should be dug out, but where there is any vitality left in the bark it may be well to allow the trees to remain at least the first season until it can be determined to what extent they are injured. It takes several years to bring a pear tree into bearing—at least two or three times as long as a peach tree—and one should therefore be correspondingly cautious in cutting down pear trees. Unfortunately, the writer can not hold out the same chances for recovery in the case of the pear orchards that are possible with the peach trees, but still moderately frozen pear trees have recovered in Michigan, and afterwards, by pruning out the weakened limbs, pretty fair bearing tops of vigorous young wood have been secured. No severe pruning, however, should be attempted this season.

IV.—THE CULTIVATION OF THE AUSTRALIAN WATTLE.[a]

By David G. Fairchild, *Agricultural Explorer, Seed and Plant Introduction and Distribution.*

The bark of the Australian black wattle tree (*Acacia mollissima* Willd.) has long been in use for tanning purposes. It does not give the leather as fine a bloom as the bark of the American oaks or the acorn cups of the valonia oak, but it tans more quickly and is in good demand for the common grades of leather.

Formerly the supply of this tan bark came from the forests of Australia, but within the last five or six years the plantations of Natal have begun to supply a large proportion of the bark, and the writer was informed by residents of that colony that wattle growing is the most profitable plant industry in the country.

A short stay in the region was not enough to put the writer in possession of all the ins and outs of this new culture, but the facts gathered during a visit to one of the largest and best managed estates in Natal may be of interest to Americans in Hawaii and elsewhere.

Hon. G. M. Sutton, a member of the legislative council of the colony, is given the credit of first agitating the question of wattle growing, and as early as 1892 he wrote urging planters to sow the seed of this Australian tree and start forests of it for its tan bark.

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[a] This brief presentation of the culture of the wattle tree and the harvesting of the bark for tanning purposes will, it is hoped, again call the attention of American tanners to this possible source of tanning material. As Mr. Fairchild points out, considerable of this bark is already being produced in South Africa, and, although it is probable that few parts of the United States proper are sufficiently free from frost to make the culture of the wattle tree profitable, it is successfully grown in the Hawaiian Islands, where it is regarded as a promising industry. A tract of 5 acres of thirteen-year-old trees at the Hawaii Experiment Station has been under experiment for a number of years, and a bulletin describing the growth of the trees and the market value of the products is now in preparation.

We are indebted to Mr. Barbour Lathrop for this paper, as the observations it contains, which were kindly placed at the disposal of the Department, were made by Mr. Fairchild during the last of Mr. Lathrop's expeditions in search of valuable seeds and plants.

A. J. Pieters, *Botanist in Charge.*

Office of Seed and Plant Introduction and Distribution,
Washington, D. C., June 25, 1904.

It had been demonstrated previously that the wattle grew unusually well upon the hillsides in certain parts of the country, so that when the price of wattle bark rose to the unusual figure of £17 sterling per ton ($82.79), which rise is attributed to successive bad harvests of the valonia oak (*Quercus ægilops* L.) in Greece and Asia Minor, it was not difficult to convince people that the experiment of its culture was worth making.

The Town Hill plantation, which covers 2,400 acres of the hilly uplands near Pietermaritzburg (Pl. I, fig. 1), is one of the largest estates in the colony. It lies about 2,700 feet above sea level, and the dark green effect of its foliage on the landscape is almost as beautiful as that produced by the cryptomeria forests of Japan.

The wattle-growing districts of Natal are scattered through the central part of the colony, especially along the railroad from Pietermaritzburg to Greytown, and one of the most important shipping centers is Dalton.

According to information given the writer by the assistant manager of the estate, the first plantings were made in 1892, and in the beginning profits were looked for only from the sale of the tan bark and firewood; but the poles which are left after the bark has been peeled from them have proved to be more desirable for mining props than those made from eucalyptus timber, and their sale adds very materially to the net receipts of the culture.

The starting of a forest of black wattles is a simple enough business operation. The virgin grass land of the rolling country is broken up about Christmas time and thoroughly harrowed. In February, rows 12 feet apart are laid out and the seed is planted 6 feet apart in the rows and lightly covered with soil, when it is left to take care of itself. Indian corn, which is called "mealies" in Natal, is sometimes sown in the 12-foot spaces between the rows of young wattle plants, and the constant stirring of the ground in cultivation is said to be of benefit to the young seedlings.

No nursery seed beds are used and no laborious planting is necessary. The following March, which is autumn in Natal, the soil between the rows is plowed for the benefit of the roots of the young trees and to guard against "grass fires," or prairie fires, as they are called in America, which are common in the grassy uplands.

In ten years from seed sowing the wattle trees are in their prime, but by the seventh year many individuals are large enough to be barked.

At ten years of age on the Town Hill plantation, trees attain a diameter of 10 inches, but the rate of growth is largely influenced by the character of the soil and probably also by individual variations in the seed.

The soil on which the Town Hill plantation is situated is a light red, friable loam, rich in iron, but considered poor in quality for cropping purposes. A layer of gravel and sand overlies a clay subsoil two to three feet below the surface, and, though supplied with plenty of moisture, the situation is a well-drained one. The wattle roots are surface feeders, and the soil in which the moisture lies very deep, it is said, is not suitable for wattle culture.

When an area of forest is old enough the harvesting of the bark is begun. This work can be carried on at all times of the year in Natal, for the bark peels easily in any season. Sixty indentured Indian coolies do all the manual labor on the Town Hill estate and are skillful enough to peel, dry, and cut the bark and to pack it in bags for export.

It is interesting to watch the process of stripping off the bark, and one is surprised at the rapidity with which it is done. With a short-handled ax the coolie clears away the dead twigs and leaves at the base of the tree, cuts through the bark as close to the ground as possible, lifts a broad strip of it high enough to get hold of it with his hands, and, with a series of strong jerks, peels off a broad strip as long as the height from the ground to the first branches of the tree (Pl. II, fig. 2). Strip after strip is pulled from the trunk in this way until it stands as bare as a telegraph pole, save the tuft of branches at the top. The tree is then felled and the work of stripping completed on such parts as, lying between the branches, could not be peeled when it was standing.

The fresh bark is thrown over poles to dry (Pl. III, fig. 3), and the tree trunks are cut into 6 or 12 foot lengths for mining timber.

A portable tramway, which is laid through the plantation (Pl. II, fig. 3) to such places as are being stripped, carries the bark to the drying sheds (Pl. III, figs. 1 and 2), which are simple but ingenious galvanized-iron affairs, so arranged that each can shelter 6 tons of the fresh bark. The long strips of bark are hung over long poles, much as the macaroni makers of Italy hang their freshly made paste out to dry, and the ends of these poles are put through rings in two heavy chains that hang from two parallel elevated bars. A series of these poles loaded with bark is fitted to the rings a foot or two apart in the chains, and one by one they are put across the parallel bars with their ends resting upon them.

In fair weather these poles, with their tan bark over them, remain hanging on the long bars, like miniature elevated railways, which extend from the sheds up the slope of the hillside. On the approach of rain a yoke of oxen is attached to the chain of poles by a wire rope, and, like shutting up the bellows of an accordion, these poles are drawn close together down the parallel bars into the shelter of the corrugated-iron roof. With the return of sunny weather the oxen again spread out the chain of poles.

The value of the bark depends largely upon its color, and it is said that the sun-dried product is best.

Once dried, the bark is chopped into short chips, packed into sacks, and is then ready for export.

From an acre of 10-year-old wattles 5 or 6 tons of bark can be taken, and at the present market prices in Natal, £6 12s. 6d. ($32.26) a ton, the gross receipts would be from $161.20 to $193.58 per acre. The cost of stripping, drying, and packing the bark amounts to £1 10s. ($7.30) per ton. To arrive at the net earnings, to this cost of harvesting, etc., must be added the cost of ten years of care, with interest on the price of the virgin land, which was valued by the assistant manager of the estate at £1 5s. to £1 10s. per acre.

To the proceeds from the sale of the bark must be added the revenue from the mining timbers, and, although the figures given can not be vouched for and will be no guide to anyone wishing to grow wattles in a country where only high-priced labor is obtainable, they support the opinion that the wattle industry pays handsomely in Natal and explain why new plantations are being put in.

A wattle forest replants itself. If one walks through the shady avenues between the rows of fully grown trees in February (Pl. II, fig. 1) the thousands of seed pods that are scattered over the carpet of dead leaves crackle under his feet, and he is prepared to understand the rapidity with which an area once cleared of trees grows up again.

On a field which had been cleared of wattles two and one-half months before, countless seedlings were springing up and some of them were already more than a foot and a half high. These naturally sown seedlings are allowed to grow until they form a thick mass covering the field, when they are thinned out most severely, and only rows 12 feet apart are left standing.

Although there may be some reproduction by sprouts from the stumps of the felled trees, the writer was informed that these sprouts were not counted on as important in the re-formation of the forest.

In fifteen months these somewhat irregular rows of trees are 18 feet high and present an appearance such as is shown in Plate I, figure 2. In four years from the time that the old forest is cut down, these rows of seedlings will have grown to such a height that they will require thinning out, and among the trees cut out in this process there are many which yield a fair quantity of bark.

Although at first thought this habit of natural seeding might seem a great advantage, it is said, on the contrary, that the cost of thinning out the seedlings is greater than the expense of planting a fresh plantation.

The greatest enemy of the wattle grower is the "grass fire." From the surrounding prairie such fires spread into the plantations and destroy them. To prevent this, nearly 50 miles of fire breaks made by plowing broad strips of prairie have been constructed about the

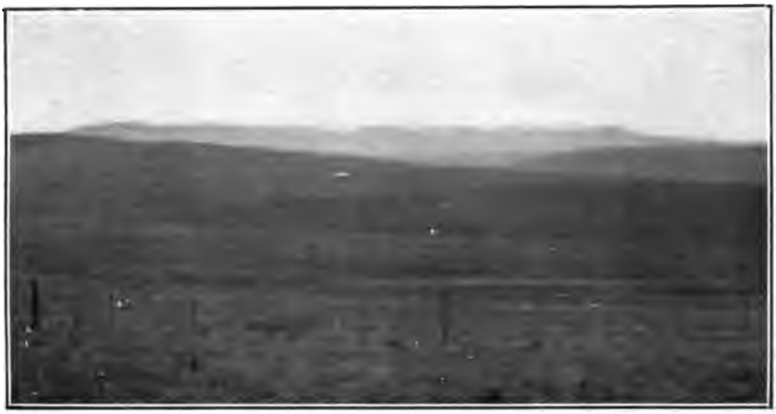

FIG. 1.—VIEW OF THE GRASSY UPLANDS OF NATAL WHERE WATTLES ARE GROWN.

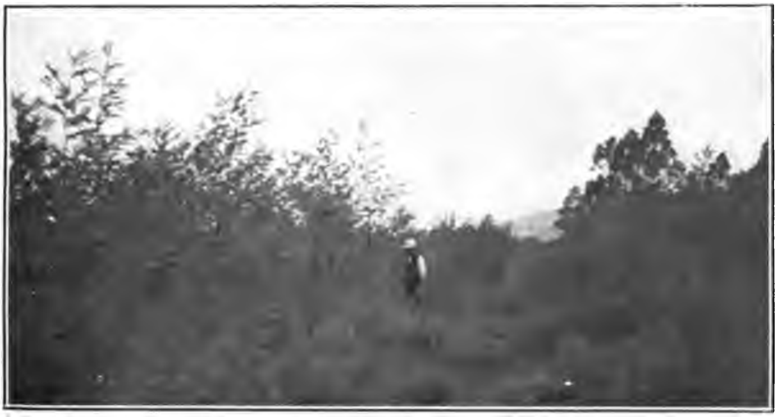

FIG. 2.—YOUNG WATTLE PLANTATION, SELF-SOWN, FIFTEEN MONTHS OLD.

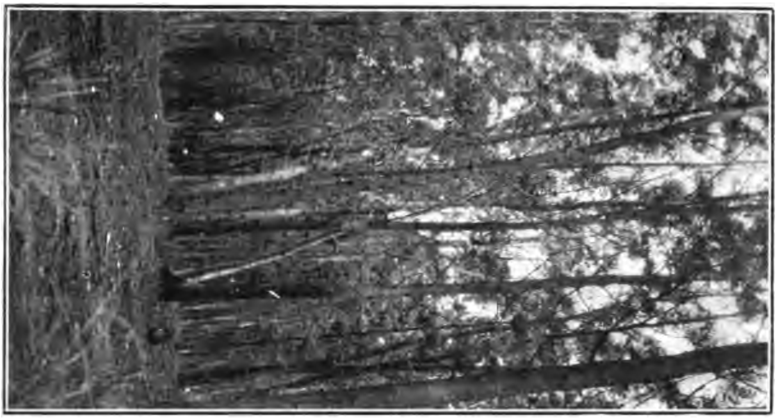

FIG. 1.—NINE-YEAR-OLD WATTLE FOREST.

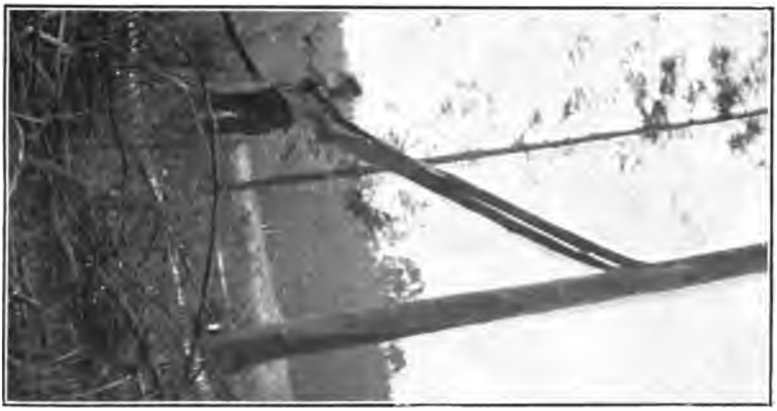

FIG. 2.—STRIPPING THE BARK FROM A NINE-YEAR-OLD TREE.

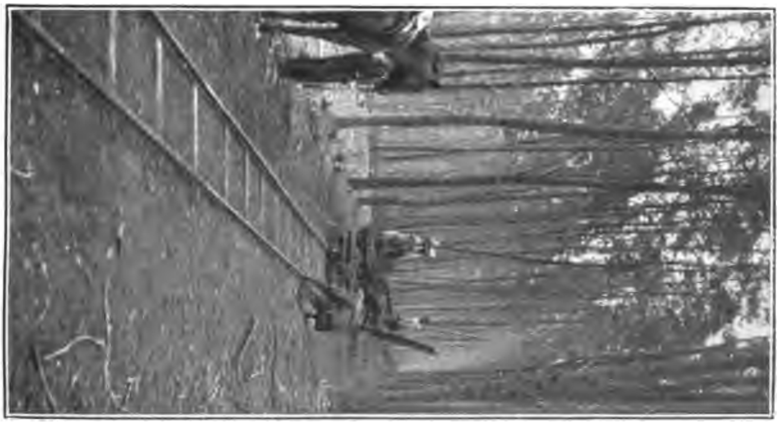

FIG. 3.—THE RAILWAY THAT HAULS THE BARK.

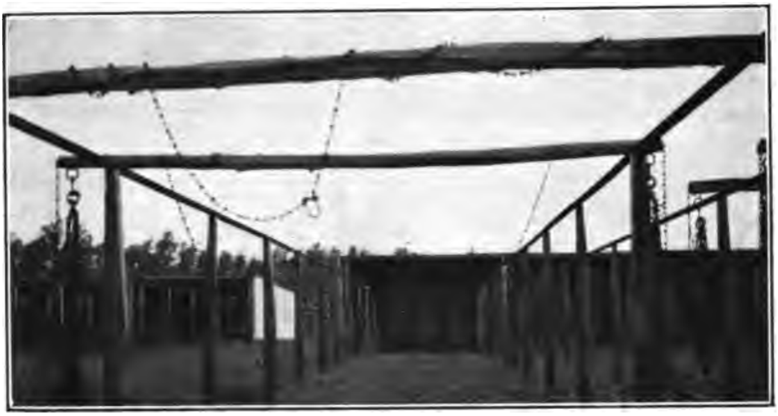

FIG. 1.—THE DRYING SHED, WITH ITS RUNWAYS FOR THE POLES.

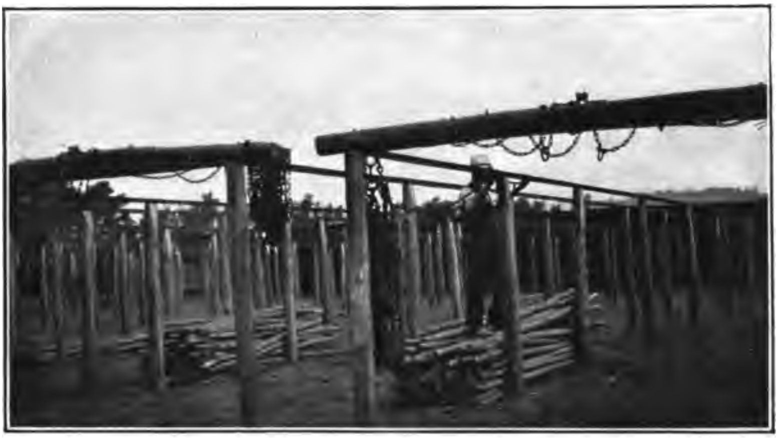

FIG. 2.—THE RUNWAYS, WITH THEIR CHAINS AND POLES.

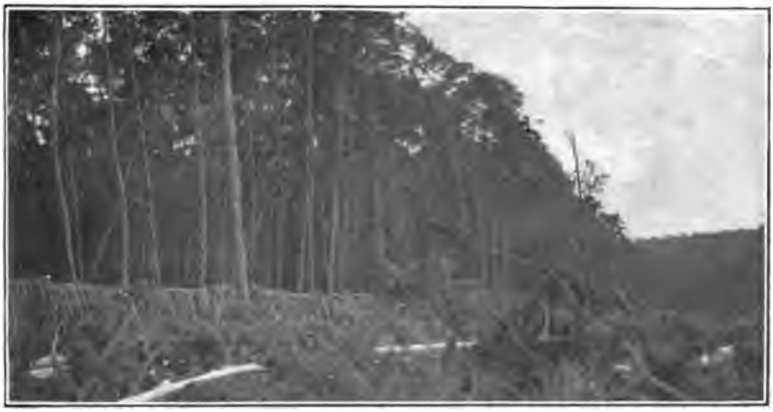

FIG. 3.—FRESHLY STRIPPED BARK HUNG UP TO DRY ON THE EDGE OF A CLEARING.

forests, and the expense of this adds materially to the original cost of establishing a wattle estate.

Two insect enemies of the wattle are a bagworm, which destroys great quantities of foliage and checks the growth of the trees, and the more destructive locust, which has retarded for over a year the growth of the trees on the Town Hill plantation. The former insects are collected and burned, and the plague of locusts is prevented by spreading about their breeding places poisoned molasses for the young to feed upon. A special locust expert is employed by the Natal government, and with his corps of laborers he poisons all the principal breeding places of the pest.

An industry which pays so well in the new country of Natal, and does not require a large amount of hand labor, sixty men being sufficient for 2,400 acres, is worthy of the attention of American cultivators. The climatic conditions seem favorable in Hawaii, but whether they are as favorable as they are in Natal, where it is claimed that the species grows more luxuriantly than in its native land, may be a question.

V.—LEGAL AND CUSTOMARY WEIGHTS PER BUSHEL OF SEEDS.[a]

By Edgar Brown, *Botanist in Charge of Seed Laboratory, Botanical Investigations and Experiments.*

INTRODUCTION.

While the selling of seeds by the measured bushel has largely disappeared in the trade, the weight per bushel still has an important value in determining grade, especially in grass sēeds, which vary greatly in quality. Redtop seed weighing 10 pounds per bushel is composed largely of chaff and contains a very small percentage of good seed, while fancy seed, containing from 85 to 95 per cent of pure seed, weighs from 35 to 40 pounds per bushel. Similar variations in weight exist in connection with the handling of other common grass seeds, such as bluegrass, orchard grass, brome-grass, rye-grass, and the fescues. The weights per bushel of grains do not vary as much as do those of grass seeds, but nevertheless the weight per bushel is an important factor to be considered in grading.

LEGAL WEIGHTS PER BUSHEL.

The weights per bushel for all seeds for which weights per bushel have been established by law are given in Table I. These have been taken from the latest statutes and have been verified by the secretary of state of each State. In several instances the legal weights are obviously misleading and should be changed. There is evidently an error in the Louisiana statute which gives the weight for both barley and rye as 32 pounds. The weights for buckwheat vary from 40 to 52 pounds in different States. The legal weights for oats should be made more nearly uniform. In Pennsylvania and West Virginia the legal weight is 32 pounds; in Virginia 30 pounds, and in Maryland 26 pounds. The legal weight for Kentucky bluegrass and redtop in all States where a legal weight has been established is 14 pounds. This weight was established before the present methods of cleaning came into general use and while the seed was sold in the chaff. Cleaned seed of good grade weighs from two to three times as much, as recorded in detail in Table I, and the legal weights should be changed accordingly.

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[a] The varying use in weights of our common field and garden seeds in different States must necessarily lead to confusion. It is hoped that a more widely disseminated knowledge of this varied usage, such as is pointed out in this paper, will tend to lessen the confusion and bring about greater uniformity. Furthermore, by calling attention to the present unsatisfactory conditions it may aid in preparing the way for the general introduction of the metric system now used in nearly all other civilized countries.

Lyster H. Dewey, *Acting Botanist.*

Office of Botanical Investigations and Experiments,
Washington, D. C., September 7, 1904.

CUSTOMARY WEIGHTS PER BUSHEL.

In numerous instances the customary weights per bushel of seeds used by the trade are not the same as the legal weights. The boards of trade and chambers of commerce in the principal cities have reported the customary weights used by them, and where these differ from the legal weights they are given in the footnotes to Table I.

Seedsmen handle a large number of grass and forage plant as well as other seeds, for few of which legal weights per bushel have been established. Table II shows the customary weights per bushel used for these seeds by representative seedsmen in the different States. In most instances two weights are given, indicating the differences in quality recognized in the trade. Well-cleaned seed of good quality will weigh approximately as much as the higher weight given.

TABLE I.—*Legal weights per bushel of seeds.*

States and Territories.	Field crops.																	
	Wheat.	Corn, shelled.	Corn in ear.	Corn in ear, unshucked.	Oats.	Barley.	Rye.	Buckwheat.	Beans.	Peas.	Cotton, Upland.	Cotton, Sea Island.	Pop corn, shelled.	Pop corn in ear.	Hemp.	Flax.	Rice, rough.	Peanuts.
Alabama	60	56	70	75	32	47	56	....	60	60	32	....	....	....	....	....	....	....
Arizona	60	54	......	...	32	45	56	....	[ff]60 55	....	....	....	....	....	....	....	....	....
Arkansas[a]	60	56	70	74	32	48	56	52	[gg]60	60	33⅓	....	....	....	....	56	....	....
California[b]	60	[b]52	......	...	[b]32	[b]50	[b]54	[b]40	......	....	....	....	....	....	....	....	....	....
Colorado[c]	60	56	70	...	32	48	56	[c]52	60	(*c*)	....	....	....	....	44	(*c*)	....	....
Connecticut	60	56	......	...	32	48	56	48	60	60	30	44	....	....	....	55	45	....
Delaware	60	56	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....
District of Columbia[cc]	....	....	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....
Florida	60	56	......	70	32	48	56	....	60	....	32	46	....	....	....	....	....	22
Georgia[d]	60	56	70	...	32	47	56	52	[gg]60	60	30	....	....	....	44	56	43	....
Idaho	60	56	......	...	36	48	56	42	......	....	....	....	....	....	....	56	....	....
Illinois[ef]	60	56	70	...	32	48	56	52	[gg]60	....	....	....	....	....	44	56	....	....
Indiana[g]	60	56	[dd]70	...	32	48	56	50	60	....	....	....	(*g*)	70	44	....	....	....
Indian Territory[cc]	....	....	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....
Iowa	60	56	70	...	32	48	56	52	60	....	....	....	....	....	44	56	....	....
Kansas	60	56	70	...	32	48	56	50	60	....	....	....	56	....	44	56	....	....
Kentucky[h]	60	56	[ee]70	...	32	[h]47	56	56	[gg]60	60	....	....	....	....	44	56	....	....
Louisiana[i]	60	[i]56	(*i*)	...	32	[i]32	[i]32	(*i*)	(*i*)	(*i*)	....	....	....	....	(*i*)	(*i*)	....	....
Maine	60	56	......	...	32	48	....	48	62	60	....	....	....	....	....	....	....	....
Maryland[j]	(*j*)	(*j*)	(*j*)	...	[j]26	(*j*)	(*j*)	(*j*)	(*j*)	(*j*)	....	....	....	....	(*j*)	(*j*)	....	(*j*)
Massachusetts[k]	60	56	......	...	32	48	56	48	60	60	30	44	....	....	....	55	45	....
Michigan	60	56	70	...	32	48	56	48	60	60	....	....	....	....	44	56	....	....
Minnesota[lm]	[l]60	56	70	...	32	[m]48	56	50	60	60	....	....	....	....	50	(*l*)	....	....
Mississippi[n]	60	56	72	...	32	48	56	48	[gg]60	60	[n]32	....	....	....	44	56	....	....
Missouri[o]	60	56	70	...	32	48	56	52	60	60	33	....	....	....	44	56	....	(*o*)
Montana	60	56	70	...	32	48	56	52	60	60	....	....	....	....	44	56	....	....
Nebraska[p]	60	56	70	...	32	48	56	52	[gg]60	60	....	....	....	....	44	56	....	....
Nevada[cc]	....	....	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....
New Hampshire	60	56	......	...	32	....	56	....	62	60	....	....	....	....	....	....	....	....
New Jersey	60	56	......	...	30	48	56	50	60	60	....	....	....	....	....	55	....	....
New Mexico[cc]	....	....	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....
New York[qr]	60	56	......	...	32	48	56	48	60	60	30	44	....	....	....	[r]55	45	....
North Carolina	60	56	......	...	32	48	56	50	......	60	30	....	....	....	....	55	44	....
North Dakota	60	56	70	...	32	48	56	42	60	60	....	....	....	....	....	56	....	....
Ohio[stu]	60	56	68	...	32	48	56	50	60	[u]60	....	....	....	[t]42	44	56	...	(*u*)
Oklahoma	60	56	70	...	32	48	56	42	60	60	....	....	....	....	....	56	....	....
Oregon	60	56	......	...	32	46	56	42	......	....	....	....	....	....	....	....	....	....
Pennsylvania[v]	60	56	......	...	32	[v]47	56	48	......	....	....	....	....	....	....	....	....	....
Rhode Island	60	56	70	...	32	48	56	48	60	60	30	44	....	....	44	56	....	....
South Carolina[w]	....	....	......	...	....	....	....	....	......	....	30	[w]42	....	....	....	....	....	....
South Dakota	60	56	70	...	32	48	56	42	60	60	....	....	....	....	....	56	....	....
Tennessee	60	56	70	74	32	48	56	50	60	60	28	....	....	70	44	56	...	23
Texas[xy]	60	56	70	72	32	48	56	42	[gg]60	....	32	....	....	....	44	56	....	....
Utah[cc]	....	....	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....
Vermont	60	56	......	...	32	48	56	48	62	60	....	....	....	....	....	....	....	....
Virginia[z]	60	56	70	...	[z]30	48	56	52	[gg]60	....	32	....	....	....	44	56	...	22
Washington[aa]	60	56	......	...	32	48	56	42	......	....	....	....	....	....	....	56	....	....
West Virginia	60	56	......	...	32	48	56	52	60	....	....	....	....	....	....	56	....	....
Wisconsin[bb]	60	56	(*bb*)	...	32	[48	56	50	60	60	30	44	....	....	44	56	45	....
Wyoming[cc]	....	....	......	...	....	....	....	....	......	....	....	....	....	....	....	....	....	....

TABLE I.—*Legal weights per bushel of seeds*—Continued.

States and Territories.	Grass and forage plants.													
	Clover.	Timothy.	Herd's grass.	Hungarian grass.	Millet.	Japanese barnyard millet.	Canary seed.	Bluegrass.	Redtop.	Orchard grass.	Amber cane.	Sorghum.	Kafir corn.	Johnson grass.
Alabama														
Arizona														
Arkansas[a]	60	60			50			14	14	14		50		28
California[b]														
Colorado[c]	60	45		(c)	(c)			14	(c)	(c)	(c)		(c)	(c)
Connecticut	60	45	45											
Delaware														
District of Columbia[cc]														
Florida					50							56		
Georgia[d]	60	45						14						
Idaho	60													
Illinois[ef]	60	45						14						
Indiana[g]	60	45			50			14		14				
Indian Territory[cc]														
Iowa	60	45		50	50			14				30		
Kansas	60	45		50	50			14				56	56	
Kentucky[h]	60	45		50	50			14		14				
Louisiana[i]	(i)	(i)		(i)	(i)		(i)	(i)		(i)		(i)		(i)
Maine			45											
Maryland[j]	(j)	(j)		(j)	(j)			(j)	(j)	(j)				
Massachusetts[k]	60	45	45			35								
Michigan	60	45		50	50			14	14	14				
Minnesota[lm]	60	45		48	48			14	14	14		57		
Mississippi[n]	60	45		50	50			14				42		
Missouri[o]	60	45		48	50			14	14	14		42		
Montana	60	45		50				14						
Nebraska[p]	60	45		50	50			14				[p]30		
Nevada[cc]														
New Hampshire														
New Jersey	64										57			
New Mexico[cc]														
New York[qr]	60	45	45					(r)	(r)	(r)				
North Carolina	60													
North Dakota	60	42			50									
Ohio[stu]	60	45		[s]50	[u]50		(u)	(u)	(u)	(u)	(u)	(u)	(u)	
Oklahoma	60	42												
Oregon	60													
Pennsylvania[v]	60													
Rhode Island	60	45		50	50									
South Carolina[w]														
South Dakota	60	42												
Tennessee	60	45		48	[hh]50		60	14	14	14		50		
Texas[xy]	60	45		48	50									
Utah[cc]														
Vermont	60	45	45											
Virginia[z]	60	45		48	50			14	12	14				
Washington[aa]	60													
West Virginia	60	45												
Wisconsin[bb]	60	45		48	50									
Wyoming[cc]														

TABLE 1.—*Legal weights per bushel of seeds*—Concluded.

States and Territories.	Grass and forage plants.								Miscellaneous.								
	English bluegrass.	Italian rye-grass.	Velvet grass.	Rape.	Soy beans.	Cowpeas.	Velvet beans, in hull.	Beggar weed.	Broom corn.	Spelt.	Castor beans.	Osage orange.	Indian wheat.	Apple seed.	Chestnuts.	Hickory nuts.	Walnuts.
Alabama																	
Arizona																	
Arkansas[a]									48								
California[b]																	
Colorado[c]	(c)								(c)								
Connecticut																	
Delaware																	
District of Columbia[cc]																	
Florida							78	62			48						
Georgia[d]																	
Idaho																	
Illinois[ef]											46						
Indiana[g]											46	33					
Indian Territory[cc]																	
Iowa									30		46	32					
Kansas	22										46						
Kentucky[h]	14										45						
Louisiana[i]	(i)	(i)		(i)		(i)			(i)		(i)	(i)					
Maine																	
Maryland[j]																	
Massachusetts[k]					58												
Michigan											46	33					
Minnesota[lm]				50					57								
Mississippi[n]											46						
Missouri[o]											46	36				(o)	(o)
Montana																	
Nebraska[p]											46	32					
Nevada[cc]																	
New Hampshire																	
New Jersey																	
New Mexico[cc]																	
New York[qr]																	
North Carolina																	
North Dakota									30	48							
Ohio[stu]									(u)		(u)	(u)					
Oklahoma									30								
Oregon																	
Pennsylvania[v]																	
Rhode Island											46			40			
South Carolina[w]																	
South Dakota									30								
Tennessee		20	7						42		46	33		40	50	50	50
Texas[xy]																	
Utah[cc]																	
Vermont													46				
Virginia[z]						60						34			57		
Washington[aa]																	
West Virginia																	
Wisconsin[bb]				50													
Wyoming[cc]																	

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[a] The Little Rock Board of Trade uses the legal weights per bushel for the State of Arkansas.

[b] The Merchants' Exchange of San Francisco uses the legal weight per bushel for the State of California for wheat. It also uses the following weights per bushel for the commodities named below:

Barley:	Pounds.	Oats:	Pounds.
Brewing	46	Black feed	30
Chevalier	53	Red feed	33
Feed	41	White feed	35
Buckwheat	50	White milling	37
Corn, shelled	56	Rye	58

[c] The Denver Chamber of Commerce and Board of Trade uses the legal weights per bushel for the State of Colorado, except for buckwheat. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Alfalfa	60	Meadow fescue (English bluegrass)	24
Amber cane	50	Millet	50
Broom corn	46	Orchard grass	14
Buckwheat	50	Peas	60
Flax	56	Redtop	14
Hungarian millet (Hungarian grass)	48	Redtop, fancy	32
Johnson grass	25	Sweet corn	50
Kafir corn	56		

[d] The Columbus Board of Trade uses the legal weights per bushel for the State of Georgia.

[e] The Chicago Board of Trade uses the legal weights per bushel for the State of Illinois.

[f] The Peoria Board of Trade uses the legal weights per bushel for the State of Illinois.

[g] The Indianapolis Board of Trade uses the legal weights per bushel for the State of Indiana. It also uses 56 pounds as the weight per bushel for shelled pop corn.

[h] The Louisville Board of Trade uses the legal weights per bushel for the State of Kentucky, except for barley, for which it uses the weight per bushel of 48 pounds.

[i] The New Orleans Board of Trade uses the legal weights per bushel for the State of Louisiana for wheat, shelled corn, and oats. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Alfalfa	60	Meadow oat-grass	14
Barley	48	Millet:	
Beans	60	German	50
Broom corn	46	Italian	50
Buckwheat	48	Mustard	58
Bur clover	8	Orchard grass	14
Canary seed	60	Osage orange	33
Castor beans	46	Peas, English:	
Clover:		Smooth	60
Alsike	60	Wrinkled	56
Crimson	60	Radish	50
Red	60	Rape	50
White	60	Rescue grass	14
Corn:		Rye	56
In ear	70	Rye-grass:	
Shelled, Adams	50	English	20
Cowpeas	60	Italian	20
Flax	56	Sorghum	50
Hemp	44	Sunflower, Russian	24
Hungarian grass	48	Teosinte	59
Japan clover	25	Timothy	45
Johnson grass	25	Turnip	58
Kentucky bluegrass	14	Vetch	60
Meadow fescue (English bluegrass)	15		

[j] The Baltimore Chamber of Commerce uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Barley	48	Oats	32
Beans	62	Oats (State)	26
Beans (State)	60	Orchard grass	14
Bluegrass	14	Peanuts:	
Buckwheat	48	African	32
Clover	60	Virginia	22
Corn:		Wilmington	28
On cob	70	Peas	60
Shelled	56	Peas (State)	56
Flax	56	Redtop:	
Hemp	44	Chaff	14
Hungarian grass	48	Fancy	32
Millet:		Rye	56
American	50	Timothy	45
German	50	Wheat	60

[k] The Boston Chamber of Commerce uses the legal weights per bushel for the State of Massachusetts.

[l] The Duluth Board of Trade uses the legal weights per bushel for the State of Minnesota. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Flax	56	Macaroni (durum) wheat	60

[m] The Minneapolis Chamber of Commerce uses the legal weights per bushel for the State of Minnesota, except for barley, for which it uses the weight per bushel of 50 pounds.

[n] The Meridian Board of Trade uses 33⅓ pounds as the weight per bushel for cotton seed.

[o] The Merchants' Exchange of St. Louis uses the legal weights per bushel for the State of Missouri and also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Hickory nuts	50	Walnuts	50
Peanuts, dry southern	22		

[p] The Omaha Board of Trade uses the legal weights per bushel for the State of Nebraska, except for sorghum, for which it uses the weight per bushel of 50 pounds.

[q] The Buffalo Merchants' Exchange uses the legal weights per bushel for the State of New York.

[r] The New York Produce Exchange uses the legal weights per bushel for the State of New York, except for flax. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Bluegrass	14	Orchard grass	14
Flax	56	Redtop	14

[s] The Cincinnati Chamber of Commerce and Merchants' Exchange uses the legal weights per bushel for the State of Ohio, except for Hungarian grass, for which it uses the weight per bushel of 48 pounds.

[t] The Cleveland Chamber of Commerce uses the legal weights per bushel for the State of Ohio, except for pop corn, in ear, for which it uses the weight per bushel of 40 pounds.

[u] The Columbus Board of Trade uses the legal weights per bushel for the State of Ohio. It also uses the following weights per bushel for the commodities named below:

	Pounds.		Pounds.
Bluegrass	14	Osage orange	33
Broom corn	46	Peanuts	24
Canary seed	60	Pearl millet	56
Cane	50	Peas, wrinkled	56
Castor beans	46	Redtop	14
Japan clover	20	Sorghum	50
Kafir corn	50	Sweet vernal grass	10
Meadow foxtail	25	Tall meadow oat-grass	12
Orchard grass	14	Wood meadow grass	14

[v] The Philadelphia Produce Exchange uses the legal weights per bushel for the State of Pennsylvania, except for barley, for which it uses the weight per bushel of 48 pounds.

[w] The Columbia Chamber of Commerce uses the weight per bushel of 45 pounds for Sea Island cotton seed.

[x] The Galveston Cotton Exchange uses the legal weights per bushel for the State of Texas.

[y] The Fort Worth Board of Trade uses the legal weights per bushel for the State of Texas.

[z] The Richmond Grain and Cotton Exchange uses the weight per bushel of 32 pounds for oats.

[aa] The Seattle Chamber of Commerce uses the legal weights per bushel for the State of Washington.

[bb] The Milwaukee Chamber of Commerce uses the legal weights per bushel for the State of Wisconsin. For corn, on cob, it also uses the weight per bushel of 75 pounds from harvest to January 1 and 70 pounds after January 1.

[cc] No legal weights.

[dd] "From harvest until December 1, 70 pounds; after December 1, 68 pounds."

[ee] "From November 1 to May 1, 70 pounds; from May 1 to November 1, 68 pounds."

[ff] "Small white beans, 60 pounds; other beans, 55 pounds."

[gg] "White beans."

[hh] "German, Tennessee, and Missouri millet."

TABLE II.—*Seedsmen's customary weights per bushel of seeds.*

Kind of seed.	Pounds per bushel.
Alfalfa	60
Amber cane	45-60
Bent grass:	
Creeping	10-20
Rhode Island	10-15
Bermuda grass	24-36
Bird's-foot clover	60
Bitter vetch	60
Bluegrass:	
Canada	14-20
Kentucky	14-30
Texas	14
Broad bean	50-60
Brome, awnless	10-14
Broom corn	45-60
Bur clover:	
Hulled	60
Unhulled	8-10
Spotted	60
Castor bean	46-60
Clover:	
Alsike	60
Crimson	60
Egyptian	60
Mammoth	60
Red	60
White	60
Cowpea	56-60
Crested dog's-tail	14-30
Fescue:	
Hard	12-16
Meadow	14-24
Red	12-15
Sheep's	12-16
Tall	14-24
Various leaved	14-18
Flat pea	50-60
Flax	48-56
Hemp	40-60
Japan clover:	
Hulled	60
Unhulled	18-25
Johnson grass	14-28
Kafir corn	50-60
Lentil	60
Lupine, white	50-60
Meadow foxtail	7-14
Meadow grass:	
Fowl	11-14
Rough-stalked	14-20
Meadow grass—continued.	
Wood	14-24
Millet:	
Barnyard	30-60
Broom corn	45-60
Common	48-50
German	48-50
Golden Wonder	48-50
Hungarian	48-50
Pearl	48-56
Milo maize	50-60
Oat-grass:	
Tall	10-14
Yellow	7-14
Orange cane	45-60
Orchard grass	10-18
Pea:	
Field	60
Garden, smooth	60
Garden, wrinkled	56
Peanut	20-30
Rape, winter	50-60
Redtop:	
Chaff	10-14
Fancy	25-40
Rescue grass	12-28
Rice	43-45
Rye-grass:	
English	10-30
Italian	14-25
Sainfoin	14-32
Serradella	28-36
Soy bean	58-60
Spelt	40-60
Sunflower	24-50
Sweet clover:	
Hulled	60
Unhulled	33
Sweet corn (according to variety)	36-56
Sweet vernal, perennial	6-15
Teosinte	40-60
Timothy	45
Velvet bean	60
Vetch:	
Hairy	50-60
Spring	60
Water grass, large	14
Wild rice	15-28
Yellow trefoil	60

B. P. I.—123. B. I. E.—60.

VI.—GOLDEN SEAL.[a]

By **Alice Henkel**, *Assistant*, and **G. Fred Klugh**, *Scientific Assistant, Drug and Medicinal Plant Investigations, Botanical Investigations and Experiments.*

HISTORY.

As in the case of many other native medicinal plants, the early settlers learned of the virtues of golden seal through the American Indians, who used the root as a medicine and the yellow juice as a stain for their faces and a dye for their clothing.

The Indians regarded golden seal as a specific for sore and inflamed eyes, and it was a very popular remedy with the pioneers of Ohio and Kentucky for this affection and also for sore mouth, the root being chewed for the relief of the last-named trouble. In the herbarium collected by Captains Lewis and Clark on their expedition to the source of the Missouri and across the country to the Pacific coast, a specimen of golden seal collected May 24, 1804, bears some notes in the handwriting of Captain Lewis concerning the use of this plant in "Kentucky and many other parts of the western country." He states that it is said to be a sovereign remedy for sore eyes, describing the nature of this disorder and giving also the method of preparing and applying this remedy. He states, further, that it makes an "excellent mouth water."

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[a] The increasing use of golden seal in medicine has resulted in a wide demand for information about the plant, its identification, geographical distribution, the conditions under which it grows, methods of collecting and preparing the rhizomes, relations of supply and demand, and the possibilities of its cultivation. This paper, with the exception of the part relating to cultivation, was prepared (under the direction of Dr. Rodney H. True, Physiologist in Charge of Drug and Medicinal Plant Investigations) by Miss Alice Henkel, Assistant in Drug and Medicinal Plant Investigations; and Mr. G. Fred Klugh, Scientific Assistant in the same office, in charge of cultural experiments in the Testing Gardens, furnished the part treating of the cultivation of this plant. In the preparation of this paper, which was undertaken to meet the demand for information relative to golden seal, now fast disappearing from our forests, many facts have been obtained from Lloyds' Drugs and Medicines of North America.

Lyster H. Dewey, *Acting Botanist.*

Office of Botanical Investigations and Experiments,
Washington, D. C., September 7, 1904.

Barton, in his "Collections for an Essay towards a Materia Medica of the United States," 1804, speaks of the use of a spirituous infusion of the root of golden seal as a tonic bitters in the western part of Pennsylvania, and of the employment of an infusion of the root in cold water as a wash for inflammation of the eyes.

According to Dr. C. S. Rafinesque, in his Medical Flora in 1828, the Indians also employed the juice or infusion for many "external complaints, as a topical tonic," and that "some Indians employ it as a diuretic, stimulant, and escharotic, using the powder for blistering and the infusion for the dropsy." He states further that "internally it is used as a bitter tonic, in infusion or tincture, in disorders of the stomach, the liver," etc.

It was not until a demand was created for golden seal by the eclectic school of practitioners, about 1847, that it became an article of commerce, and in 1860 the root was made official in the Pharmacopœia of the United States, which place it has held to the present day.

HABITAT AND RANGE.

Golden seal occurs in patches in high open woods where there is plenty of leaf mold, and usually on hillsides or bluffs affording natural drainage, but it is not found in very moist or swampy situations, in prairie land, or in sterile soil. It is native from southern New York to Minnesota and western Ontario, south to Georgia and Missouri, ascending to an altitude of 2,500 feet in Virginia. It is now becoming scarce throughout its range. Not all of this region, however, produced golden seal in abundance. Ohio, Indiana, Kentucky, and West Virginia have been the greatest golden-seal producing States, while in some localities in southern Illinois, southern Missouri, northern Arkansas, and central and western Tennessee the plant, though common, could not be said to be sufficiently plentiful to furnish any large amount of the root. In other portions of its range it is sparingly distributed.

COMMON NAMES.

Many common names have been applied to this plant in different localities, most of them bearing some reference to the characteristic yellow color of the root, such as yellowroot, yellow puccoon, orangeroot, yellow paint, yellow Indian paint, Indian paint, golden root, Indian dye, curcuma, wild curcuma, Ohio curcuma, wild turmeric, Indian turmeric, jaundice root, and yellow eye; other names are eyebalm, eyeroot, and ground raspberry. Yellowroot, a popular name for it, is misleading, as it has been applied to other plants also, namely, to goldthread, false bittersweet, twinleaf, and the yellowwood. The name golden seal, derived from its yellow color and the seal-like scars on the root, has been, however, generally adopted.

DESCRIPTION OF THE PLANT.

Golden seal (*Hydrastis canadensis* L.) belongs to the same family as the buttercup, namely, the crowfoot family (Ranunculaceæ). It is a perennial plant, and the thick yellow rootstock sends up an erect, hairy stem about a foot in height, around the base of which are two or three yellowish scales. The stems as they emerge from the ground are bent over, the tops still remaining under ground, and sometimes the stems show some distance above the surface before the tops are brought out from the soil. The yellow color of the roots and scales extends partly up the stem so far as it is covered by soil, while the portion of the stem above ground has a purplish color. Golden seal has only two leaves (rarely three), the stem bearing these seeming to fork at the top, one branch supporting a large leaf and the other a smaller one and a flower. Occasionally there is a third leaf, much smaller than the other two and stemless. The leaves are prominently veined on the lower surface, and are palmately 5 to 9 lobed, the lobes broad, acute, sharply and unequally toothed. The leaves are only partially developed at flowering time and are very much wrinkled, but they continue to expand until they are from 6 to 8 inches in diameter, becoming thinner in texture and smoother. The upper leaf subtends or incloses the flower bud. (Pl. IV, fig. 1.)

Early in spring, about April or May, the flower appears, but few ever see it, as it lasts only five or six days. It is greenish-white, less than half an inch in diameter, and has no petals, but instead three small petal-like sepals, which fall away as soon as the flower expands, leaving only the stamens—as many as 40 or 50—in the center of which are about a dozen pistils, which finally develop into a round, fleshy, berry-like head. The fruit ripens in July or August, turning a bright red and resembling a large raspberry, whence the common name *ground raspberry* is derived. Each fruit contains from 10 to 20 small, black, shining, hard seeds. (Pl. IV, fig. 2.)

If the season has been moist, the plant sometimes persists to the beginning of winter, but if it has been a dry season it dies down soon after the fruit is ripe, so that by the end of September no trace of the plant remains above ground. In a patch of golden seal there are always many sterile stems, simple and erect, bearing a solitary leaf at the apex, but no flower.

Mr. Homer Bowers,[a] of New Ross, Ind., who propagated golden seal from the seed for the purpose of studying its germination and growth, states that the plant grown from naturally sown seed often escapes observation during the first year of its existence owing to the fact that in this entire period nothing but two round seed leaves are produced (fig. 2), and at this stage the plant does not look materially different from other young seedlings. During its second year from seed one basal leaf is sent up (fig. 3), followed in the third year by another smaller leaf and the flower.

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[a] A Contribution to the Life History of Hydrastis Canadensis, Bot. Gaz., 16:73–82, 1891.

DESCRIPTION OF THE RHIZOME, OR ROOTSTOCK.

The rhizome (rootstock) and rootlets of golden seal, or hydrastis, as it is also known in the drug trade, are the parts employed in medicine. The full-grown rhizome, when fresh, is of a bright yellow color both internally and externally, about 1½ to 2½ inches in length and from one-fourth to three-fourths of an inch in thickness. Fibrous yellow rootlets are produced from the sides of the rhizome. (Fig. 4.) The fresh rhizome contains a large amount of yellow juice, and gives off a rank, nauseating odor. When dry the rhizome measures from 1 to 2 inches in length and from one-eighth to one-third of an inch in diameter. It is crooked, knotty, wrinkled, of a dull brown color outside, and breaks with a clean, short, resinous fracture, showing a lemon-yellow color if the root is not old. If the dried root is kept for a long time it will be greenish yellow or brown internally, and becomes inferior in quality. On the upper surface of the rhizome are several depressions, left by former annual stems, which resemble the imprint of a seal; hence the name golden seal. The fibrous rootlets become very wiry and brittle in drying, breaking off readily and leaving only

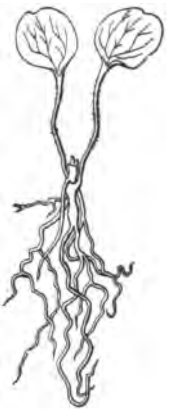


FIG. 2.—Golden seal seedling at the end of the first season's growth.

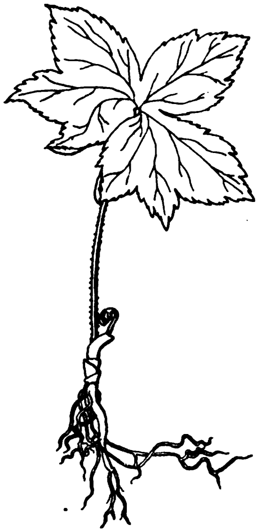


FIG. 3.—Golden seal, second year from the seed.

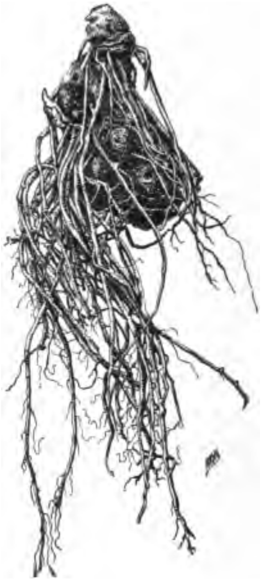


FIG. 4.—Rhizome, or rootstock, of golden seal.

small protuberances, so that the root as found in commerce is sometimes almost bare. The dried rhizome also has a peculiar, somewhat narcotic, disagreeable odor, but not so pronounced as in the fresh material; an exceedingly bitter taste; and a persistent acridity which causes an abundant flow of saliva when the rhizome is chewed. The most important constituents of the rhizome are the three alkaloids—hydrastin, berberin, and canadin. It contains also starch, albuminous matter, resin, sugar, fatty matter, and inorganic salts.

Hydrastis acts chiefly upon the mucous membranes and glandular system, and to some extent upon the nervous system. It is a valuable drug in disordered conditions of the digestive organs and in catarrhal affections of any of the mucous membranes when unaccompanied with acute inflammation. In the various diseases of the mucous membranes it is administered both internally and locally. Hydrastis imparts its properties to water, glycerin, or alcohol.

COLLECTION AND PREPARATION OF THE ROOT.

The root should be collected in autumn after the plants have matured seed. Spring-dug root shrinks far more in drying and always commands a lower price than the fall-dug root. After the roots are removed from the earth they should be carefully freed from soil and all foreign particles. They should then be sorted, and small, undeveloped roots and broken pieces may be laid aside for replanting. After the roots have been cleaned and sorted they are ready to be dried or cured. Great care and judgment are necessary in drying the roots. It is absolutely necessary that they should be perfectly dry before packing and storing, as the presence of moisture induces the development of molds and mildews, and of course renders them worthless. The roots are dried by exposure to the air, being spread out in thin layers on drying frames or upon a large, clean, dry floor. They should be turned several times during the day, repeating this day after day until the roots are thoroughly dried. If dried out of doors they should be placed under cover upon indication of rain and at night, so that they may not be injured by dew. After the roots are thoroughly dried they may be packed as tightly as possible in dry sacks or barrels, and they are then ready for shipment.

DIMINUTION OF SUPPLY.

Although, perhaps, in some secluded localities golden seal may still be found rather abundantly, the supply is rapidly diminishing, and there is a growing scarcity of the plant throughout its range. With the advance of civilization and increase in population came a growing demand for many of our native medicinal plants and a corresponding decrease in the sources of supply. As the rich forest lands of the

Ohio Valley and elsewhere were required for the needs of the early settlers they were cleared of timber and cultivated, and the golden seal, deprived of the shelter and protection necessary to its existence, gradually disappeared, as it will not thrive on land that is cultivated. Where it was not destroyed in this manner the root diggers, diligently plying their vocation, did their share toward exterminating this useful little plant, which they collected, regardless of the season, either before the plants had made much growth in spring or before the seeds had matured and been disseminated, thus destroying all means of propagation. The demand for the root appears to be increasing, and the time seems to be not far distant when this plant will have become practically exterminated, so far as the drug supply is concerned. The cultivation of golden seal seems now to have become a necessity in order to meet the demand and save the plant from extinction. Prior to 1900 there seemed to be no one, so far as the Department of Agriculture could ascertain, who had ever attempted the cultivation of golden seal for the market. From that time on, many inquiries were directed to the Department by persons who were quick to note the upward tendency of prices for golden seal, and there are now several growers in different parts of the country who have undertaken the cultivation of golden seal on a commercial scale.

CULTIVATION.

The United States Department of Agriculture has been carrying on experiments in the cultivation of golden seal on a small scale at Washington, D. C., since the spring of 1899, in the hope that methods might be worked out according to which this valuable wild drug plant could be grown on a commercial scale. In these experiments the aim has been to imitate the natural conditions of growth as closely as possible. The results that have thus far been obtained, while not as complete in some respects as would be desirable, seem to justify the conclusion that golden seal can be successfully cultivated. The methods of operation described apply to the conditions at Washington, and the treatment may need to be somewhat modified under other conditions of soil and climate.

NECESSARY SOIL CONDITIONS.

The soil conditions should imitate as closely as possible those seen in thrifty deciduous forests. The soil should contain an ample supply of humus, well worked into the ground, to secure the lightness and moisture-retaining property of forest soils. The best form of humus is probably leaf mold, but good results may be obtained by mulching in the autumn or early winter with leaves, straw, stable manure, or similar materials. After the soil has been prepared and planted, it is well to add a mulch in the fall as a partial protection to the roots during the winter, and the decay of this material adds to the value of the soil by the time the plants appear in the spring. The forest conditions are thus imitated by the annual addition of vegetable matter to the soil, which by its gradual decay accumulates an increasing depth of a soil rich in materials adapted to the feeding of the plants and to the preservation of proper physical conditions. The growth of weeds is also hindered to a considerable extent. If sufficient attention is given to the presence of this mulch, the nature of the underlying soil is of less importance than otherwise. In the case of clay the thorough incorporation of a large amount of decayed vegetable matter tends to give lightness to the otherwise heavy soil, facilitating aeration and drainage. Since the roots of the golden seal do not grow well in a wet soil, thorough drainage is necessary. A lighter, sandy soil is improved by the addition of humus, since its capacity to hold moisture is thereby increased and the degree of fertility is improved. The looser the soil, the easier it is to remove the roots in digging without breaking or injuring them. Before planting, the soil should be thoroughly prepared to a depth of at least 6 or 8 inches, so as to secure good aeration and drainage. The good tilth thus secured will be in a degree preserved by the continued addition of a mulch. A further advantage of a careful preparation is seen in a decrease in the amount of cultivation required later.

FERTILIZERS.

The fertilizers that may be used with profit in the growing of golden seal have not yet been determined, but it is probable that potash and phosphates would increase the yield, especially if the soil is light. So far as is known, no preference can be given to any particular compounds of either potash or phosphoric acid. Two hundred pounds of kainit, or 50 pounds of muriate of potash and from 200 to 300 pounds of superphosphate per acre would in all probability prove useful. The nitrogen is supplied by the humus and need not be added in concentrated form.

ARTIFICIAL SHADE.

Since the golden seal grows naturally in the woods, it must be protected from the full light of the sun by artificial shade. That used in connection with the experiments of the Department was made of ordinary pine plastering lath nailed to a suitable frame elevated on posts. The posts were of cedar 8½ feet long, set 2½ feet in the ground in rows 11 feet apart, and 16 feet distant from each other in the rows. Supports 2 by 4 inches were set on cedar blocks 2 feet long sunk below the soil surface in the middle of the 16-foot spaces. Pine pieces 2 by

4 inches were nailed edgewise to the tops of the posts and supports. The posts were notched to receive the 2 by 4 inch sticks. Pieces 2 by 4 inches were nailed across these at intervals of 4 feet. The laths were nailed to these, leaving spaces about an inch wide.

This shade has been found to be satisfactory, as it is high enough above the ground to allow such work as is necessary in preparing and cultivating the land. If the lathing is extended 2 or 3 feet beyond the posts on the sunny sides, injury from the sun's rays at the edges of the area will be prevented. The sides may be protected by portable board walls about 2 feet high set around the edges. Protection from injury by winds when the tops are large may be thus secured. Too much dampness should be guarded against in the use of the board sides, since conditions might be developed favorable to the damping-off fungus and to aphides during the hot rainy periods.

The cost of lath shade over a tenth of an acre, at Washington, was probably considerably greater than will be necessary in districts where lumber is cheaper. The lumber will probably cost from $500 to $700 per acre, and the labor of the farm can be utilized at times when other work is not pressing.

USE OF TREES AS SHADE.

Trees may be used for shade, but this is in some ways to be regarded as unsatisfactory. When the shade produced is of the right density, the use of the moisture and raw food materials of the soil by the trees is an undesirable feature.

ATTENTION REQUIRED.

The cultivation of golden seal is simple. Having secured a deep, loose soil, rich in humus renewed annually by the application of a new mulch, the removal of weeds is the chief care. The soil, if properly prepared, will tend to maintain itself in good condition. The manner of treatment is very similar to that required by ginseng, which is also a plant of the moist woods. If the ground is thoroughly prepared, beds are not absolutely necessary. The plants may be grown in rows 1 foot apart and 6 inches apart in the rows. Beds may be thought by some to be more convenient, enabling the grower to remove the weeds and collect the seed more readily. If beds are used, they may be made from 4 to 8 feet wide, running the entire length of the shade, with walks from 18 inches to 2 feet wide between. Boards 6 or 8 inches wide are set up around the sides of the beds, being held in place by stakes driven on each side of the boards in the center and at the ends. These beds are filled with prepared soil, and the plants are set 8 inches apart each way.

METHODS OF PROPAGATION.

There are three possible ways of propagating the plant: (1) By seed; (2) by division of the rhizomes; (3) by means of small plants formed on the stronger fibrous roots (fig. 5). Thus far no success has been attained in growing golden seal from the seed. The second and third methods have given better results.

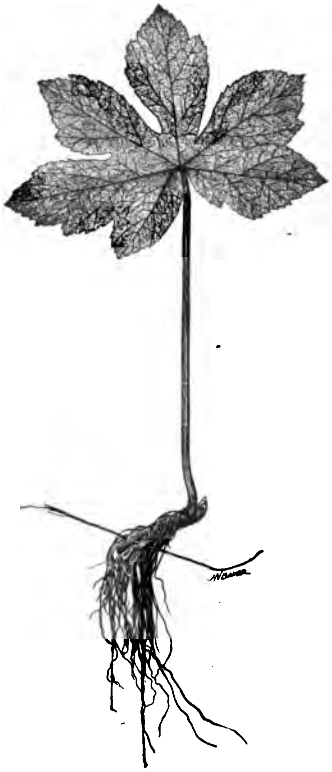


FIG. 5.—Plant formed from bud on fibrous root of golden seal.

EXPERIMENTS WITH SEEDS.

Seeds just after ripening were planted in sandy soil mixed with well-rotted stable manure and mulched lightly with manure. Other lots were kept over winter in a dry condition and planted in the spring in potting soil in a greenhouse. No seedlings have appeared, but a long rest period may be demanded and the seed may yet germinate.

EXPERIMENTS WITH DIVIDED RHIZOMES.

In the spring of 1902, 40 plants were secured and planted under a shade of a temporary character, but the season was too far advanced to permit of much growth during that year. In 1903, proper shade was supplied, all other conditions were better, and the plants made a good growth. The crop was dug about the middle of November, 1903; the roots were weighed and divided. They were again planted, and in May, 1904, there were found to be 150 strong plants and a few smaller ones as a result of this division, an increase of 275 per cent. This method of propagation seems to be the most important and the other two of secondary importance. The processes are simple and no skill is needed. The plant dies down in late summer and the stem decays, leaving a scar in its place on the rhizome. Two or more buds are formed on the sides of the rhizome and these accumulate energy for growth the following spring. If the root is cut into as many pieces as there are buds, giving each plant a portion of the rhizome, some fibrous roots, and one or more buds, the number of the plants can be doubled. The roots are planted and mulched and the process is complete. The rains pack the soil around the roots and they are ready to grow when spring comes. The process may be repeated every year and the number of roots increased indefinitely.

EXPERIMENTS WITH PLANTS FROM FIBROUS ROOTS.

The stronger fibrous roots of the larger plants dug in the autumn of 1903 were found to contain buds, which were formed from a few inches to a foot from the rhizome. (Pl. V.) Some were about half an inch long, but the majority of them were smaller. The larger ones need no special treatment and may be planted with the main crop. The smaller ones should be planted in boxes or beds of well-prepared soil at a distance of about 3 inches apart, mulched with a thin coating of leaf mold, or similar material, and grown in shade until large enough to transplant to the shelter with the larger plants. They will probably require at least three years to reach their full development. If they could be left undisturbed in the beds where they are formed they would receive nourishment from the older rhizomes and perhaps grow faster, but it is probably best to divide the older roots every year where propagation alone is desired, planting the smaller roots and the plants made by division of the rhizomes. The larger roots are marketed to more advantage than the smaller ones, so it is best to have the surplus consist of the larger roots. The frequent working of the soil allowed by this treatment will keep it in better condition than if left undisturbed for a longer period.

YIELD OF ROOTS.

The yield from the small plat grown by the Department was 4 pounds of green roots to an eighth of a square rod of soil, or 5,120 pounds per acre. This, when dried, would give about 1,500 pounds of marketable roots. The conditions were not very good, the shade being too close to the plants, and the plants being set too far apart. The yield will probably be larger with the shade now in use. The 150 roots obtained by dividing the above crop now occupy less than one-fourth of a square rod, and are set in rows 1 foot apart and 6 inches apart in the rows.

TIME NECESSARY TO MATURE CROP.

The number of years necessary to produce the largest crop has not been definitely determined, but the roots begin to decay after the fourth year, and the central and largest part of the root decays at the oldest scar, leaving two or more plants in place of the old one. No advantage can be gained by growing the plants more than three years, and probably very little by growing them more than two years. For propagation alone one year will give good results, while for maintaining a constant area and producing a crop, two or three years, depending upon the growth made, will give a good crop of large, marketable roots.

MARKET CONDITIONS.

Golden seal is a root the price of which has fluctuated widely, because of the alternate oversupply and scarcity, manipulation of the market, lack of demand, or other influences. High prices will cause the diggers to gather the root in abundance, thus overstocking the market, which the next season results in lower prices, at which diggers refuse to collect the root, thus again causing a shortage in the supply. Lack of demand usually brings about a shrinkage in price, even though the supply is light, while an active demand will cause prices to advance in spite of a plentiful supply. The arrival of spring-dug root has a weakening effect on the market, although the fall-dug root is always preferred. For the past few years, however, high prices have been steadily maintained, and there appears to be but one cause for this, and that is, as already pointed out, that the forests no longer yield unlimited quantities of this valuable root, as in former years, and the scanty supply that can be had is inadequate to meet the constantly increasing demand.

HIGHEST AND LOWEST PRICES.

The following table, taken from files of the Oil, Paint, and Drug Reporter, shows the highest and lowest prices quoted for golden seal in the New York market each month during the past ten years, and also the highest and lowest points touched each year from 1894 to 1903, inclusive. The figures are based on the closing quotations of each successive week:

Month.	1894.		1895.		1896.		1897.		1898.		1899.		1900.		1901.		1902.		1903.	
	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.
January	23	23	18½	18	22½	22½	27	25	40	38	43	43	60	60	57	55	50	50	54	52
February	23	22	18	18	22½	22	27	25	45	40	70	43	60	58	56	55	50	50	54	54
March	22	22	18	17¼	22	22	30	26	42½	38	70	62½	57	54	55	53	52	48	54	54
April	22	21	18½	17½	22	21	27	27	45	40	70	68	54	54	52	50	52	50	54	54
May	21	21	17½	17½	21	20	27	26	50	45	75	60	54	53	49	49	52	50	54	54
June	21	19	17½	17½	20	20	26½	25	48	40	60	55	50	50	47	45	52	51	54	53
July	19	19	17½	17	20	20	25	25	40	35	53	49	50	47½	57½	43	52	51	53	53
August	19½	19	17	17	20	19½	25	24	50	38	52	50	54	47½	58	57½	52	52	57½	53
September	19½	19	18½	17	19½	19½	27	24	45	45	52	50	60	55	58	50	54	52	75	70
October	19	18½	20	18	24	21	62½	35	50	45	58	56	55	55	54	50	54	54	75	74
November	19	18½	22	20	29	24	50	45	52	47½	60	58	58	55	52	52	53	52	74	74
December	18½	18½	23	22½	28	27	45	40	47½	45	62½	60	58	57	52	52	52	52	74	74
Whole year	23	18½	23	17	29	19½	62½	24	50	35	75	43	60	47½	58	43	54	48	75	52

According to the market reports contained in the Oil, Paint, and Drug Reporter, the year 1904 opened with a quotation of 74 to 75 cents, which soon advanced (in one week early in February) from 76 cents to 95 cents. A still further advance occurred about the end of February, when the price went up from $1 to $1.25 per pound. In March the market was almost destitute of supplies, but lack of interest brought the price down to $1.10. In May the price advanced again to $1.25, and it was stated that the local supplies were being held by a small number of dealers, although it was believed that together they held not more than 1,000 pounds. About June 1 the arrival of spring-dug root caused the market to sag, prices ranging from $1.10 to $1.18 during that month, and in July from 90 cents to $1.10. In August the lowest price was $1.15 and the highest $1.50, no discrimination being made between the fall-dug and the spring-dug roots. From September 1 to October 15 the price of golden seal varied but little, $1.35 being the lowest and $1.40 the highest quotation. No supplies worth mentioning can be obtained in the West; the stock in New York is short, and the demand, especially for export, is increasing. It is impossible to ascertain the exact annual consumption of golden seal root, but the estimates furnished by reliable dealers place these figures at from 200,000 to 300,000 pounds annually, about one-tenth of which is probably used for export.

It will be observed that the price of this article is very sensitive to market conditions, and it seems probable that the point of overproduction would be easily reached if a large number of golden seal growers were to meet with success in growing large areas of this drug.

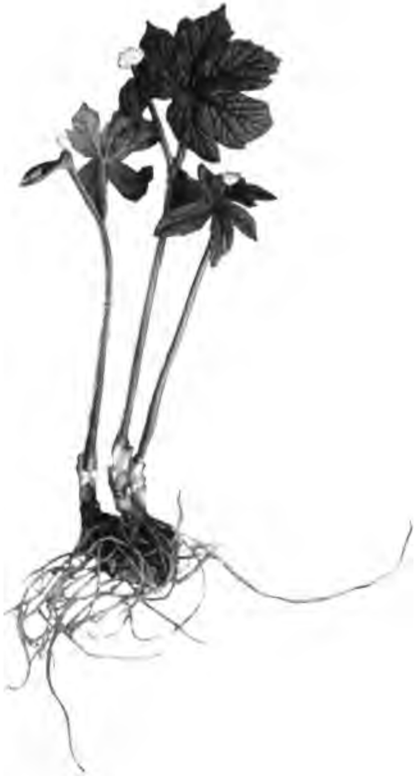


FIG. 1.—GOLDEN SEAL, FLOWERING PLANT.

(*Reduced one-half.*)

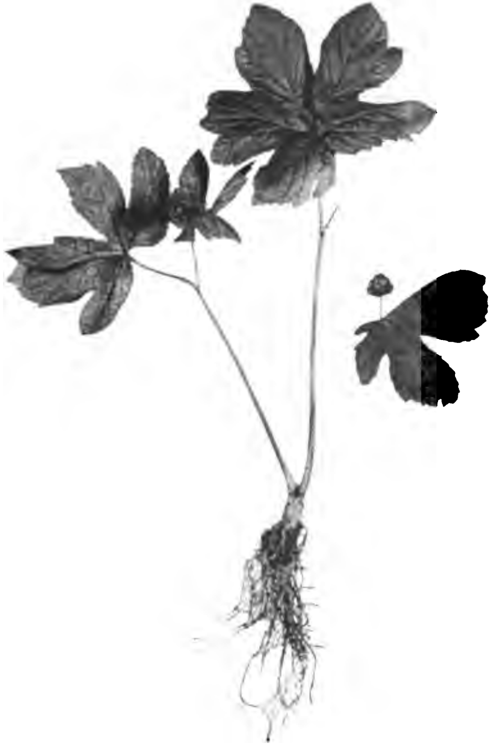
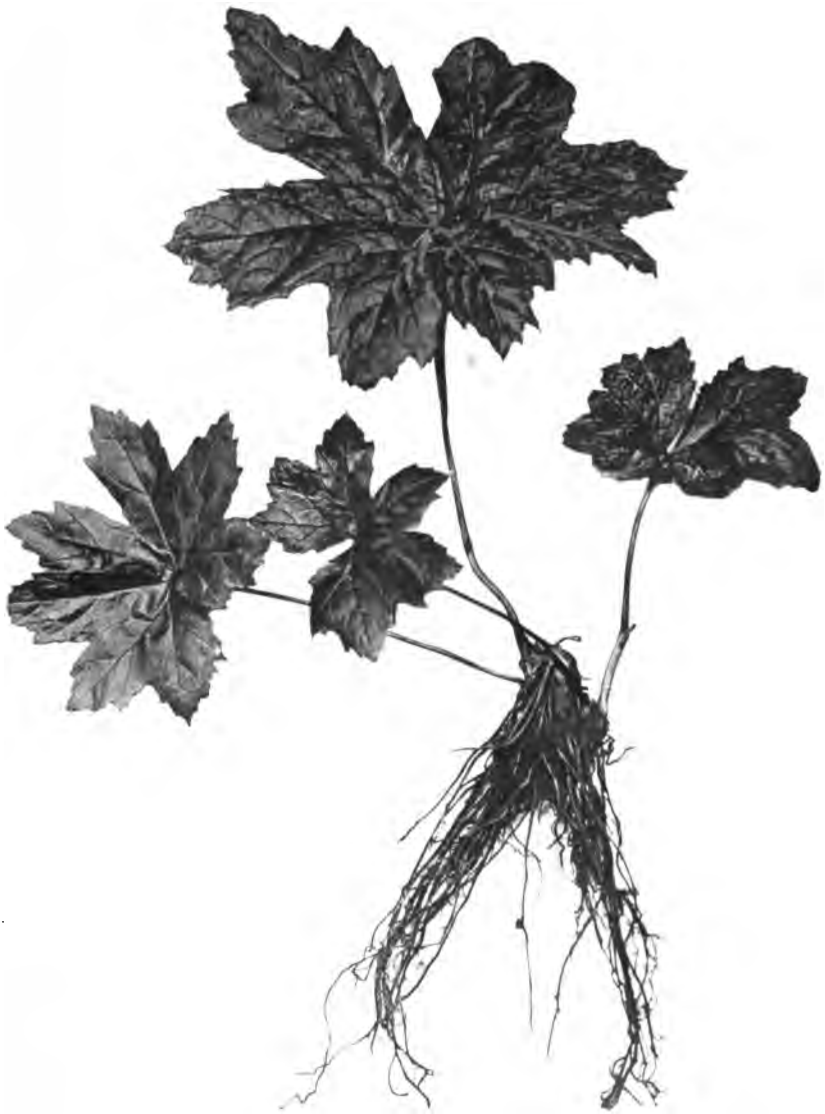


FIG. 2.—GOLDEN SEAL, FRUITING PLANT, WITH FRUIT AND LEAF DETACHED.

(*Reduced one-half.*)



GOLDEN SEAL, SHOWING BUD ON FIBROUS ROOT.

(*Natural size.*)

(Continued from page 2 of cover.)

No. 18. Observations on the Mosaic Disease of Tobacco. 1902. Price, 15 cents.
19. Kentucky Bluegrass Seed: Harvesting, Curing, and Cleaning. 1902. Price, 10 cents.
20. Manufacture of Semolina and Macaroni. 1902. Price, 15 cents.
21. List of American Varieties of Vegetables for the Years 1901 and 1902. 1903. Price, 35 cents.
22. Injurious Effects of Premature Pollination: With General Notes on Artificial Pollination and the Setting of Fruit Without Pollination. 1902. Price, 10 cents.
23. Berseem: The Great Forage and Soiling Crop of the Nile Valley. 1902. Price, 15 cents.
24. The Manufacture and Preservation of Unfermented Grape Must. 1902. Price, 10 cents.
25. Miscellaneous Papers: I. The Seeds of Rescue Grass and Chess. II. Saragolla Wheat. III. Plant Introduction Notes from South Africa. IV. Congressional Seed and Plant Distribution Circulars, 1902–1903. 1903. Price, 15 cents.
26. Spanish Almonds and Their Introduction into America. 1902. Price, 15 cents.
27. Letters on Agriculture in the West Indies, Spain, and the Orient. 1902. Price, 15 cents.
28. The Mango in Porto Rico. 1903. Price, 15 cents.
29. The Effect of Black Rot on Turnips: A Series of Photomicrographs, Accompanied by an Explanatory Text. 1903. Price, 15 cents.
30. Budding the Pecan. 1902. Price, 10 cents.
31. Cultivated Forage Crops of the Northwestern States. 1902. Price, 10 cents.
32. A Disease of the White Ash Caused by Polyporus Fraxinophilus. 1903. Price, 10 cents.
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